XVI. *Description of the Cavern of Bruniquel, and its Organic Contents.*

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Received August 20, 1868,—Read January 7, 1869.

PART II.—EQUINE REMAINS.

WITH the remains of animals from the Cavern of Bruniquel I brought away evidences of about thirty individuals of the Horse-kind. Like those of other herbivorous quadrupeds, they consisted of broken-up parts of the skeleton, chiefly portions of jaws with teeth, fragments of the limb-bones, and detached teeth.

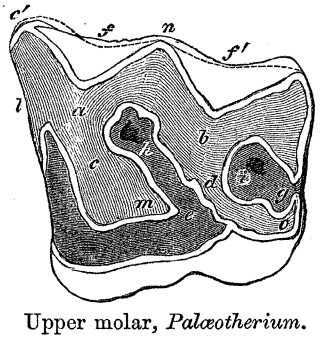
From the less instructive fragments left behind, or consigned to the rubbish-basket, I estimated that not fewer than a hundred individuals of the Equine genus had contributed to that proportion of the organic contents of the cavern which had been exhumed at the time of my exploration (January and February, 1864).

Of these, as of the other larger quadrupeds (*Bos primigenius*, &c.), the major part were of immature individuals—young colts and fillies; not more than four specimens of the entire molar series of permanent teeth (and I secured for the British Museum all such) had been extricated from the breccia and the hardened 'limon noir' and 'limon rouge' at the close of my second visit, February 1864. All these Equine remains were found mixed pell-mell with those of the other quadrupeds, owning no particular locality in the cavern, and at various depths from immediately beneath the then remaining thick marginal stalagmite (fig. 3, p. 520, *s s*) to a depth of 5 feet in the 'limon rouge' (ib. 2), about the middle of the cavern.

On a cursory comparison of the teeth, they indicated two kinds or varieties of Equines, slightly differing in size and in the relative size of the last molar tooth (Plate LVII. fig. 5; Plate LX. figs. 2–6).

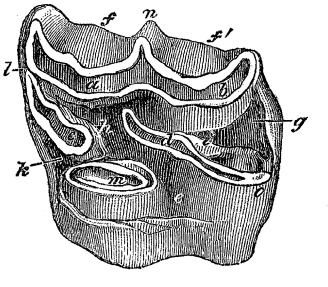
Before entering on the description of these fossils, I premise an explanation of the letters denoting the parts of the grinding-surface of the upper and lower molars in the accompanying Plates and Woodcuts (figs. 1–6), in order to abridge future remarks and facilitate the comprehension of the comparisons.

Fig. 1.



Upper molar, *Palæotherium*.

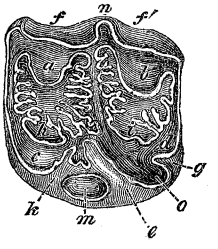
Fig. 2.



Upper molar, *Paloplotherium*.

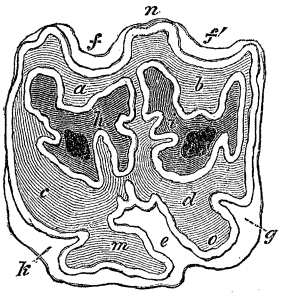
Upper Molars.—CUVIER, with his usual acumen, had detected beneath a general resemblance to the ruminant pattern in the Horse's grinders the more essential correspondence with that of the (perissodactyle) section of Ungulates to which the genus is essentially allied*. I here contrast an upper molar (*m* 1) of *Palæotherium* (fig. 1), of *Paloplotherium* (fig. 2), and of *Hipparion* (fig. 3) with that of *Equus*†, fig. 4.

Fig. 3.



Upper molar, *Hipparion*.

Fig. 4.



Section of upper molar, Horse (*Equus caballus*).

The longitudinal tract of dentine extending along the outer side of the crown ('colline longitudinale externe,' Cuv.) is partially divided by the two indents, *f*, *f'*, into an anterior, *a*, and posterior, *b*, lobe: the tract of dentine along the inner side of the crown is divided by an oblique fold or valley, *e*, into two lobes, *c*, *d*, extending obliquely backward from the outer tract, *a*, *b*, toward the inner side of the crown; these are the 'deux collines transversales' of CUVIER. Besides the fold, *e*, there is a shorter posterior one, *g*. These oblique folds or valleys are of more even depth in *Palæotherium* (fig. 1) than in *Rhinoceros* and *Equus* (fig. 4); they are so shallow, midway, in the latter, as to lead to an early separation of their respective beginnings or entries, *g* and *e*, from their terminations, *h* and *i*: the anterior oblique lobe, *c m*, is separated by the valley, *e h*, from the posterior oblique lobe *d o*; which is defined by the valley, *g i*, entering from the posterior side of the crown. The blind terminations of the two valleys, *h* and *i*, are more dilated, and their enamel-margin is more wavy, in *Hipparion* (fig. 3) and in *Equus* (fig. 4) than in *Palæotherium*, fig. 1; and, being soon cut off from the rest of the valley, in the wear of the equine tooth, they form the irregular crescentic islands, *h*, *i*, in figs. 3 & 4, leaving the entries of the valleys as shallow or short indents, *g*, *e*. The grinding-surface of the horse's tooth is made further complex by an indent, *k*, near the anterior internal angle, which, being nearly met by a fold of the main valley *e*, defines the acces-

* "Les dents mâchelières supérieures de chevaux sont prismatiques comme celle de bœuf et de buffle, et marquées de même de quatre croissans."..."Au reste cette forme de couronne, tout en se rapprochant des ruminans, ne s'éloigne pas autant du rhinocéros qu'on pourrait le croire: elle peut aussi se réduire à une colline longitudinale externe et à deux collines transversales, qui envoient chacune un crochet en arrière."—*Recherches sur les Ossemens Fossiles*, Ed. 8vo, 1834, t. iii. pp. 202, 203.

† This comparison is given and illustrated in my 'British Fossil Mammalia,' 8vo, 1846, p. 384, figs. 126 & 143, and in Art. "Odontology," Encycl. Britan. vol. xvi. 1858. See also RÜTIMEYER, 'Beiträge zur Kenntniss der fossilen Pferde,' 8vo, 1863, tab. i.

sory lobe *m*, just as the indent *g* less definitely marks a corresponding production, *o*, of the lobe *d*. Thus, in the upper molar of the Horse, fig. 4, we define the 'antexternal lobe,' *a*, the 'postexternal lobe,' *b*, the 'antoblique lobe,' *c*, the 'postoblique lobe,' *d*, and the 'internal lobule,' *m*; also the islands, anterior, *h*, and, posterior, *i*, which are the dilated and severed terminations of the antoblique, *e*, and postoblique, *g*, valleys; it becomes necessary to note also the anterior indent, *k*, and the lobular production, *o*.

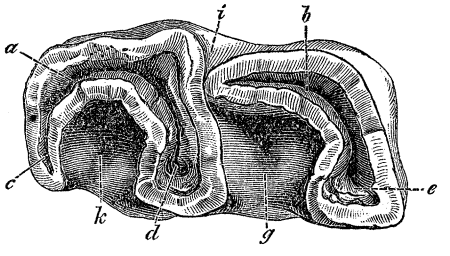
The genus *Paloplotherium* (fig. 2) manifests an instructive modification of the palæotherian upper molar surface approximative to that of *Equus*. The indent, *k*, is present and so deep that the accessory lobule, *m*, continues longer disconnected from the antoblique lobe, *c*, than in *Equus*; both the oblique valleys, *g* and *c*, are also deeper. What renders this modification of the upper eocene Palæotherioid the more interesting and suggestive is, that the Equine animal (*Hipparion*, fig. 3), of the succeeding (miocene) tertiary period, also long retains the accessory lobule, *m*, with its circle of enamel distinct.

Lower molars.—Save in Proboscidians and Tapiroids the lower grinders of Perissodactyles are divided into five lobes (fig. 5, and Plates LVII.–LIX.)—two outer, *a* and *b*, and three inner, *c*, *d*, *e*—by one external, *i*, and two internal enamel-folds or indents, *k* and *g*.

In *Palæotherium* the internal folds are simple and wide, reducing the inner lobes to the mere internal terminations of the two outer lobes which constitute the main part of the grinding-surface.

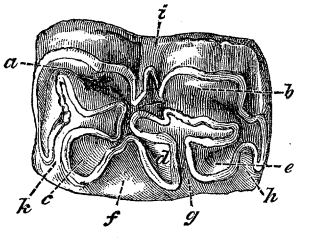
In *Rhinoceros* (fig. 5) the antinternal fold, *k*, resembles that in *Palæotherium*; but the

Fig. 5.



Lower molar, *Rhinoceros*.

Fig. 6.



Lower molar, *Equus*.

postinternal fold, *g*, slightly expands as it penetrates the crown, and better defines the postinternal lobe, *e*: it is continuous with the outer fold, *i*, until the crown is partly worn down; prior to which there is an approach to the tapiroid or dilophodont type of grinding-surface.

In *Hipparion* and *Equus* (fig. 6) besides the antinternal fold, *k*, there is a midinternal fold, *f*, which is wide and shallow; the postinternal one, *g*, is narrow, deep, and expands abruptly at its termination, like *k*, in the fore-and-aft direction, after the pattern of the capital T. The antinternal fold, *k*, penetrating the fore part of the crown, dilates and runs along the same antero-posterior line as the terminal expansion of *g*, and divides the antinternal, *c*, from the antexternal lobe, *a*, just as the expansion of the fold, *g*, divides the lobes *d* and *e* from the lobe *b*. Finally, *Hipparion* shows short indents near the outer

and inner parts of the back surface of the crown which define a small accessory hind lobule or 'talon.' In *Equus* (Plates LVII.–LIX. *m* 3) the greater development of this lobule, *l*, adds length to the working-surface of *m* 3—as the production of the lobe *a* in advance of the fold *k*, in *p* 2, makes that fold internal, as it is in *Rhinoceros* and *Palæotherium*, and adds length to the fore part of that grinder, producing it into a more or less acute angle.

Specific modifications.—Premising this definition and explanation of the parts of the grinding-surface of the upper and lower molars of the Equine dentition, there remains an obstacle in carrying out the comparisons of those characters in the Cave Equines with other extinct and existing kinds which has opposed all who have undertaken work analogous to the present.

To those, indeed, who may have access to specimens of the skulls and teeth of the known existing species of *Equidæ*, and to the teeth of defined fossil kinds, the difficulty is not felt in regard to the acquisition of personal conviction. But without, or away from, such opportunities of comparison, the help to be had from published figures of the dentition of Horses, Zebras, and Asses is very scanty, and of a kind inapplicable, or difficult and doubtful in its application.

Camper has given a side view, in his sketchy style, of the left side of the mandible of a young Zebra, with the deciduous molars *in situ*, and demonstrating, for the first time, the deciduous canine in any Equine (Œuvres de P. Camper, 1803, vol. ii. 8vo, pl. xxvi. fol. figs. 1, 4). In the plate the subject is reduced one-half, and the characters of the grinding-surface of the molars are wanting.

Cuvier has given a side view of the teeth *in situ* of *Equus caballus*, but reduced to one-fourth the natural size, in his 'Ossemens Fossiles,' 4to ed. 1822, p. 108, *Cheval*, pl. i. fig. 1. He has also given figures of the grinding-surface of the permanent teeth of the left side of the upper jaw of a horse (ib. *Cheval*, pl. ii. fig. 2), and of the right side of the lower jaw of a horse (ib. fig. 4). Similar figures of the deciduous dentition of a foal (*Poulain*) are added (ib. figs. 1 & 3, not figs. 1 & 2 as stated in the text, p. 105); but each of these figures is reduced to two-thirds of the natural size, and the surface of the grinders is little (if at all) abraded.

The text of Cuvier leaves us to infer that the figures in pl. ii. are of the Horse (*Cheval*, =*Equus caballus*); but the species is not more precisely denominated. Laurillard, in the posthumous edition of the 'Ossemens Fossiles,' does not give better information. In the description of the plates added to that edition, Planche 59, the reference is merely *Cheval*, plate ii. (Explication des Planches, p. 28).

I draw attention to this circumstance, because the comparisons which I have been led to make, and to illustrate by the accompanying drawings, between the different kinds of Equines have led me to suspect the possibility that the skull of an *E. asinus* may have been the subject from which the artist Huet drew the figures 2 and 4 of the plate *Cheval*, pl. ii. in the second volume of the 4to edition of the 'Ossemens Fossiles.'

The richly illustrated 'Ostéographie' of De Blainville does not supply what is really

needful for the comparisons in question. The grinding-surface of the permanent dentition of *Equus caballus* is given in "*G. Equus*, pl. ii.," with outer and inner views of the teeth *in situ*; but these figures show the parts reduced to one-fourth the natural size. Side views of the skull and teeth of *Equus asinus*, *E. hemionus*, *E. quagga*, *E. zebra*, *E. Burchellii*, are also given at the same or a greater degree of reduction; but there are none of the grinding-surface. They are thus with difficulty and uncertainty, if at all, available in comparing the characteristics of the complex grinding-surface of the premolar and molar teeth in extinct and existing species.

Of the Equine teeth figured, of the natural size, in my 'History of British Fossil Mammals' (8vo, 1846), those from the upper jaw of *Equus caballus* are the working-surface of the third grinder, *p* 4 (*op. cit.*, fig. 142), and of the first grinder, *p* 2 (*op. cit.*, fig. 151): that from the lower jaw is of the third grinder, *p* 4 (*op. cit.*, fig. 144). From the upper jaw of *Equus fossilis* is figured the grinding-surface of *p* 4* (*op. cit.*, fig. 143); and, from the lower jaw, that of *p* 4 (*op. cit.*, fig. 145†). Of the *Equus plicidens*, from the upper jaw, the working-surface of the first grinder, *p* 2, is given in fig. 152; and that of the second grinder, *p* 3, in fig. 153, p. 393, *op. cit.* Two upper molars of a small extinct species called *Asinus fossilis*, are given in figs. 157, 158, *op. cit.*‡

H. v. Meyer§ gives figures, of the natural size, of some upper and lower teeth of *Hipparion*, and adds an outline figure of an upper molar of a recent *Equus* (tab. xxxii. fig. 34).

Rütimeyer, in his excellent 'Beiträge zur Kenntniss der fossilen Pferde,' &c., 8vo, 1863, has adhered to the rule of my 'History of British Fossil Mammalia,' and has given the figures of the grinding-surface of the teeth of the natural size. They include, of *Equus caballus*:—from the upper jaw, a premolar, tab. i. fig. 5, unworn, and fig. 9, worn, and fig. 11, a germ of a deciduous molar; from the lower jaw, tab. iii., a worn deciduous molar and one unworn, a premolar, *p* 2, a molar, *m*^{1}, and three premolars, *p* 2, *p* 3, *p* 4, Taf. iv. fig. 45. Of *Equus fossilis*, Ow., are figured, *m* 1, *m* 2, *d* 2, 3, 4 of the upper jaw, and of the lower jaw a germ or unworn crown of *d* 4, the premolars *p* 2, *p* 3, *p* 4, also *m* 2. Of *Hipparion* are figured, the lower deciduous molars and the first molar, *m* 1, Taf. iii. figs. 28, 29; also the premolars *p* 2, *p* 3, *p* 4, and *m* 1, Taf. iv.

Hensel, in his excellent account of the *Hipparion mediterraneum*, has given figures of the grinding-surface of the upper molars, Taf. iii., of that extinct Miocene species, which agree in generic character with the *Hip. gracile* from Eppelsheim.

In the comparison of fossil Equine molars the close general conformity of character of grinding-surface, which serves so easily and satisfactorily to determine the genus or family, leaves the closer approximation, as to species, to a comparison of the details of

* The minor breadth of the deciduous molars of this species, as represented by Rütimeyer, confirms the differential character of *Eq. fossilis* as deduced from this tooth, of which the figure is reproduced in a subsequent Paper, p. 567, fig. 1.

† This figure is reproduced, p. 570, fig. 4. ‡ This figure is reproduced, p. 567, fig. 2.

§ Beiträge zur Petrifaktenkunde (I. Fossile Pferdenartige Thiere, January, 1832); in 'Nova Acta Phys. Med. Akad. Naturæ Curiosorum,' &c. tom. xvi. pars post. 4to, 1833.

that complex type; and these details can only be satisfactorily contrasted, in the absence of the specimens themselves, by faithful figures, of the natural size, of the whole dental series of the several known species of *Equidæ*.

Such aid in the determination of the fossil teeth of the Horse-tribe, the want of which is greatly felt by palæontologists, I propose to supply, so far as the materials have been at my command; and I have caused carefully accurate drawings to be made, under my inspection, of the grinding- or working-surface of the permanent teeth of the following existing kinds of Equines:—

Equus caballus ♂, *E. asinus* ♂, *E. Burchelli* ♀, *E. zebra* (molar series, of nearly adult), *E. hemionus* ♂ (or Kiang), and *E. quagga* ♂.

Equus caballus.—The subjects of Plate LVII. figs. 1 & 2, are from a stallion of a nearly full-blood hunter, which stood 15½ hands high.

The series of upper molars have a very moderate degree of curvature, convex outwardly (Plate LVII. fig. 1, *p* 2 to *m* 3): the degree of convergence of the right and left series is shown in the reduced figure, Plate LXI. fig. 6, Phil. Trans. 1869, Part II. The first functional premolar (Plate LVII. fig. 1, *p* 2) has the grinding-surface anteriorly produced and pointed, *a'*; the last grinder, *m* 3, has the same surface contracted posteriorly, but less produced and ending more obtusely; its antero-posterior extent exceeds that of the contiguous molar, *m* 2, in a greater degree than in smaller varieties of *Eq. caballus* (see Table of Admeasurements, p. 552). In all the molars the outer longitudinal channels, *f*, *f'*, are broad and more or less flat at the bottom, the anterior one, *f*, being the deepest, the posterior one, *f'*, having the posterior boundary least defined; and that boundary is wanting in *m* 3. The intervening ridge, *n*, is rather broad, is flattened, and in the premolars is slightly indented or canaliculate. The lobes, *a*, *b*, are irregularly crescentic, with a slightly wavy enamel contour. The internal lobe, *m*, is oblong, antero-posteriorly produced both backward and forward, as at *p*; but, in this direction, least so in *p* 2, most so in *m* 3. It is represented by the circular summit of a detached column of enamelled dentine in *Hipparion* (cut, fig. 3, *m*). The hind end of *m* 3 is subbilobed. The length of the upper molar series is 7 inches 6 lines; the premolars forming rather more than half that extent.

The right and left series of upper grinders very slightly converge anteriorly. The interspace between the hindmost grinders is 3 inches 2 lines; that between the foremost is 2 inches 4 lines.

The series of the lower grinders (Plate LVII. fig. 2) is straight, equally divided between the false and true molars; the whole, as in other Ungulates, are narrower in proportion to their fore-and-aft breadth than the upper grinders, upon which they work as does the hammer upon the anvil; and they decrease in transverse thickness from the penultimate premolar (*p* 3) backward.

The outer longitudinal groove, *i*, indents the crown more deeply as the grinder recedes in position, at least from *p* 2 to *m* 2. The antinternal enamel-fold, *k*, bifurcates more completely than in *Hipparion*, the anterior prong being short and inclining outward;

the posterior prong extends backward along the anterior third of the grinding-surface. The mid internal fold, *f*, is deeper than in *Hipparion*. The postinternal fold, *g*, penetrates one-third the thickness of the crown, then extends pretty equally forward and backward, like the cross of the capital T; the forward production is longest in the two anterior, *p* 2, *p* 3, and shortest in the two posterior grinders, *m* 2, *m* 3. The hind lobule, *l*, decreases in transverse and increases in fore-and-aft extent from the second to the sixth grinders, in which it rather suddenly attains its maximum.

The above particulars are, in the main, rather generic than specific characters of the existing equine lower grinders; but the definition is requisite for carrying out subsequent comparisons, in which the specific marks of the molars of *Eq. caballus* will be made more apparent.

Equus asinus.—The subjects of Plate LVIII. figs. 1 & 2 are from a male Ass of the ordinary English domestic race and average size, about eight years old. In the upper series of grinders (fig. 1) the degree of oblique attrition of *p* 2 occasions the appearance of the working-surface of that tooth being more produced and acute anteriorly than it is in less worn and more evenly worn specimens. Besides the general inferiority of size of the teeth, that of *m* 3 is relatively less than in *E. caballus*, and it is not bilobed behind; the outer longitudinal channels, *f*, *f'*, are more evenly curved or concave; and, as the same character prevails in the inner enamel-wall of the lobes *a*, *b*, these are more regularly crescentic in shape. The longitudinal ridge, *n*, is relatively narrower; the posterior boundary of the channel, *f'*, is not produced in *m* 2 and *m* 3, and but feebly so in *m* 1. The lobule, *m*, has less antero-posterior extent than in the Horse. In the molars of a she-ass I find the inner margin of this lobe feebly indented near the middle*. A slight excess of fore-and-aft over transverse diameter of grinding-surface is recognizable in the Ass—such excess not being seen in the permanent grinders, *p* 3–*m* 2, of the Horse. The length of the upper molar series is 5 inches 10½ lines in the male, and 6 inches in one of the female Asses here examined: in the latter the interval between the right and left molars, *m* 3, is 2 inches 6 lines; between the right and left premolars, *p* 2, 1 inch 9 lines. The premolars form a greater share of the length of the grinding series than in the Horse.

In the lower molar series the relative inferiority of size of *m* 3, as compared with *E. caballus*, is also seen; and, as in the upper series, the three premolars occupy a larger extent of jaw compared with the three molars, than they do in *Eq. caballus*. The anterior fork of the fold *k* is more extended transversely toward the outer side of the crown.

Equus hemionus.—The subjects of Plate LVIII. figs. 3 & 4 are from a male Kiang (*Eq. hemionus*, Pallas?), from a skull ascribed to that species in Gray and Gerrard's 'Catalogue of the Bones of Mammalia in the Collection of the British Museum,' 8vo, 1862, p. 274. The skull is marked '976, *h*,' and was transmitted from Nepal by B. H. Hodgson, Esq., H.E.I.C.'s Resident in that Province. It may have been received from Tibet. It

* I am indebted to Professor Wortley Axe, of the Royal Veterinary College, for the opportunity of comparing specimens of the Ass's dentition with those in the British Museum.

is specifically identical with the skull, 976 *d*, from the North of Ladakh, Tibet, presented to the British Museum by the Earl of GIFFORD, as of the Kiang or 'Wild Horse' of Tibet, which is most probably the same species as the 'Dshiggetai,' or *Eq. hemionus*, from the Mongolian plains, described by PALLAS*.

I do not find the grinding-surface of the teeth of this Equine anywhere figured; the outside view of the dentition in the much reduced profile of the skull in DE BLAINVILLE'S 'Ostéographie' (*G. Equus*, pl. ii.) is unavailable for such purpose and comparisons as the subject of the present Memoir requires.

The series of the upper grinders resembles that in the Ass, and differs from that in the Horse in the greater relative extent of the premolar part. The front grinder, *p* 2, terminates more obtusely; the last grinder, *m* 3, is relatively of less fore-and-aft breadth than in most horses, especially the larger varieties; it is less contracted behind than in the Ass; it is, in the Kiang here figured, subbilobed as in the Horse. The longitudinal channels, *f*, *f'*, are less concave than in the Ass, and resemble more those in the Horse; the intervening ridge, *n*, is narrower than in the Horse, but is indented in some of the teeth; the lobes, *a*, *b*, are less regularly crescentic than in the Ass. The lobule, *m*, in *p* 2, is more prominent in relation to its fore-and-aft extent than in Horse or Ass; but in the succeeding grinders this character is lost; the fore part, *p*, of the lobule, *m*, is more produced, more equal to the hind production, than in either Horse or Ass. The posterior fold or indent, *g*, in *m* 3, is deeper, and the general pattern of the grinding-surface of that tooth differs less from that of *m* 2 and *m* 1 than in Horse or Ass. The series of the upper molars, as in the Horse, is less curved than in the Ass. The length of the series is 6 inches 1 line; that of the series of lower grinders is 6 inches 2 lines. These teeth are relatively narrower transversely than in the Horse; the relative proportions of premolars to molars, in both jaws, is the same as in the Ass.

Equus quagga or *E. quaccha*.—The subjects of Plate LIX. figs. 1 & 2, are from the skull of a male Quagga in the British Museum, obtained from the Orange River, South Africa. The characters of the grinding-surface of the teeth are here, for the first time, figured of the natural size. The premolar part of the grinding series, like that in *Equus caballus*, is more nearly equal in longitudinal extent to the molar part, especially in the upper jaw, than it is in the Kiang or Ass; and this is due to the anterior grinder, *p* 2, being relatively shorter, and to the posterior one, *m* 3, being relatively longer antero-posteriorly, than in *E. hemionus* and *E. asinus*; but the last molar is more contracted posteriorly than in the Kiang, and is there more deeply bilobed.

In the upper molar series (fig. 1) the outer longitudinal channels resemble in shape those in the Horse; but the anterior one, *f*, is relatively wider in *p* 3 and *p* 4 than in the Horse or Ass. The lobule, *m p*, in *p* 3, is less thick from without inwards than in the Kiang, but is as short from before backwards, differing, with the Kiang, in this respect, from both Horse and Ass. In the succeeding grinders it gains slightly in antero-posterior breadth, and becomes flattened on the inner side and reduced in transverse thick-

* 'Novi Commentarii Academiæ Scientiarum Imp. Petropolitanæ,' t. xix. (1774), p. 394.

ness, and that to a degree greater than in Horse or Ass. The fore part of the upper grinding series bends inward more than in any of the foregoing Equines.

In the lower series of grinders (fig. 2) the outer longitudinal fold, *i*, is less complex than in the Ass, less deep than in the Kiang, still less so than in the Horse; the antinternal fold, *k*, is more complex, in *p* 2 and *p* 3, than in Horse, Ass, or Kiang. The terminal expansion of the fold *g* is wider, in the transverse direction of the tooth, than in the foregoing Equines. In the proportional extent of the premolars the Quagga agrees with the Kiang and Ass.

Equus Burchelli.—The subjects of Plate LIX. figs. 3 & 4, are from the skull of a full-grown female Dauw, from Caffraria, in the British Museum (No. 854 *a*).

On the right side of the upper jaw (fig. 3), the rudimental representative of *p* 1 in *Hipparion* and *Palæotherium* is retained, situated on the inner side of the anterior lobe or production of *p* 2, close to the fold *k**.

In the pattern and proportions of the upper molar series the Dauw closely resembles the Quagga. The grinding-surface of the last molar, *m* 3, has the well-marked bilobed termination: but the longitudinal channels, *f*, *f'*, of the antecedent grinders are more regularly concave, and the lobes *a*, *b* (in fig. 13, *p* 3) are more crescentic. The ridge *n*, as in the Kiang, Quagga, and Ass, is narrower, more simple, and more produced than in the Horse. The lobe *m*, in *m* 1 and *m* 2, is thicker transversely, and makes that side of the tooth more convex or prominent. The fore part of this lobe is less produced than in the Kiang.

In the lower molars (fig. 4) the terminal expansion of the fold *k* is less complicated with secondary foldings than in the Quagga, at least in *p* 3 and *p* 4, the Dauw in this particular resembling the Kiang and the Ass. The mid internal fold, *f*, is deeper and more angular than in the Kiang.

Equus zebra.—The drawing of the grinding-surface of the right upper molar series (Plate LX. fig. 1) is from the skull of a young full-grown male Zebra, from South Africa, in the British Museum (No. 706 *b*), showing a phase of dentition answering to that between the fourth and fifth year in the Horse. The last premolar, *p* 4, is just attaining the level of *p* 3 and *m* 1; the summits of the inner lobes, *c*, *d*, are beginning to be abraded, as are those those of their productions, *m*, *o*—the former showing the condition of the detached enamelled lobule which, by its longer retention of the insular character, is characteristic of the Hipparion's molars. The last molar, *m* 3, has cut the gum, but not reached the grinding-level. This tooth, so seen, presents a smaller relative size than in the Ass; but when abrasion and growth shall have brought a larger part of the crown

* In my 'Odontography' this denticle is described as follows:—"The first deciduous molar is very minute, and is not succeeded, as in the Anoplothere, by a permanent premolar; yet remaining longer in place than the largest deciduous molars behind, it represents the first premolar, and completes the typical number of that division of the grinding series" (p. 572). Accordingly, to facilitate the comparisons with Hipparion, Palæotherium, and Anoplotherium, this denticle is marked *p* 1 in the Plates—a circumstance which has led to inference and comments which reference to the text would have shown to be groundless.

to the grinding-surface, the proportion will be that shown in the Ass (Plate LVIII. fig. 1, *m* 3).

The antero-external angle in *p* 3 and *m* 2 is thicker and more indented than in the foregoing Equines. The lobule *m* is relatively smaller and less produced from before backward than in the Horse—the Zebra in this respect resembling the other striped Equines and the Asses, as it does in the greater antero-posterior extent of the grinder, compared with its breadth. The lower grinders of the Zebra show no differences from those of the Dauw worth figuring.

Some characters distinctive of *Equidæ* may be noted in the part of the jaw and teeth anterior to the grinders, the relative extent of this part to the molar series varying in different species. Thus, measured from the fore part of *p* 2 to the front margin of the incisor *i* 1, the extent in the upper jaw of the Horse equals *p* 2 to *m* 3 inclusive, less one-third of that molar (*m* 3); in the Kiang it equals *p* 2 to *m* 3, less two-thirds of *m* 3; in the Ass it equals *p* 2 to *m* 2 inclusive; in the Quagga it equals *p* 2 to *m* 2 inclusive, less one-third of *m* 2; in the Dauw it equals *p* 2 to *m* 2, less one-half of *m* 2. There is a corresponding difference in the relative extent of the diastema, from *p* 2 to the alveolar border of *i* 3, to the extent of the molar series; thus the diastema equals in the Horse *p* 2 to *m* 2 inclusive, less three-fifths of *m* 2; in the Kiang *p* 2 to *m* 1 inclusive, less one-eighth; in the Ass *p* 2 to *p* 4, less one-fifth; in the Quagga *p* 2 to *p* 4, less one-fourth; in the Dauw *p* 2 to *p* 4, less one-tenth.

Thus the relative extent of the diastema is greatest in the Horse, least in Quagga. The canine tooth is nearer the middle of the diastema in the upper jaw of the Horse than in the smaller Equines, especially the Ass.

The incisors appear to be relatively larger in the striped Equines than in the Ass, Kiang, and Horse.

Comparison of the teeth of Equus spelæus *with those of existing Equines.*

Having offered these preliminary remarks, with the requisite illustrations of the dentition of most of the existing species of *Equidæ*, I proceed to the comparisons of that of the Equines obtained from the Cavern of Bruniquel.

Provisionally, for convenience of reference, I designate them as belonging to an *Equus spelæus*.

Of the upper grinders of such Cave-Equines, from Bruniquel, the portions of jaws including the entire series of those teeth indicated two varieties, as above remarked.

The following were notable in a comparison of the first of them (Plate LX. fig. 2) with the corresponding part of the dentition of the Horse (*E. caballus*, Plate LVII. fig. 1). The specimen from the Cavern is the left upper jaw. The series of teeth therein (fig. 2) resembles the upper molar series of the Horse in the slight degree of curvature. The last molar, *m* 3, though not so large relatively as in the Horse's teeth figured, is not so small as in other recent Equines: it is as strongly bilobed behind as in *Eq. caballus*. The outer longitudinal ridge, *n*, is moderately thick and indented (in *p* 3). There is

less inequality of extent between the false and true molars than in the striped Zebras and Asses. The inner lobule, *m*, is antero-posteriorly extended, chiefly backwards; it is not so thick transversely, not so prominent beyond the termination *o* of the lobe *d*, in *p* 3, as in the Horse. The external longitudinal channels are more regularly concave than in the Horse's jaw figured.

I am disposed to regard the affinities of this Cave-Equine, as indicated by the characters of the upper molar series, as nearer the *E. caballus* than the other existing species. It has belonged to a smaller variety than the present average-sized horses; suggesting an animal about the size of a Spanish genet, or a pony of $13\frac{1}{2}$ hands high.

By reference to the Table of Admeasurements, p. 552, it will be seen that the molar series of the smaller variety of *Equus caballus* differs only by one line in longitudinal extent from that in BURCHELL'S Zebra.

The specimen of this Zebra here compared is of a mare; and the same sexual condition may also relate to the size of the teeth in the Cave-Equine compared (Plate LX. fig. 2). The first grinder, *p* 2, in *Equus spelæus* has the anterior lobule, *a'*, shorter, and the internal lobule, *m*, a little longer, in proportion to its breadth, than in the Horse. The two outer ridges, *n*, *r*, are less prominent; the outer concavities, *f*, *f'*, are less deep; but these may relate to the greater degree of attrition of the crown in the Cave-species. In the four succeeding molars, the inner lobule, *m*, in *Equus spelæus*, shows a longer and more angular grinding-surface, *i. e.* the fore-and-aft diameter of this surface is proportionally greater, *e. g.* than in the *E. Burchelli*. This diameter prevails over the transverse one in *m* 2 and *m* 3. The grinding-surface of *m* 3 is rather longer in *Equus spelæus* than in *Equus Burchelli*, and chiefly through the greater extension backward of the two posterior lobes; the transverse breadth of the tooth is not increased in the same proportion.

The upper molar series of the second variety of Cave-Equine (Plate LX. fig. 3) indicates a larger animal than the preceding. The disposition of the series of teeth presents a greater curvature, in this respect resembling the Zebra (Plate LX. fig. 1), a resemblance which is repeated in the shape and relative size of the last molar, *m* 3. But in the proportions and configuration of the premolars the present Cave-fossil very closely agrees with *Equus caballus* (Plate LVII. fig. 1). The ridge, *n*, and grooves, *f*, *f'*, in *p* 3, closely adhere to the pattern shown in the same tooth of the Horse (Cut, fig. 4). In *p* 4 the ridge becomes less flattened, and the channels more regularly curved. In *m* 1 and *m* 2 of the Cave-Equine the postero-external channel, *f'*, wants the boundary given by the outward production of the postexternal angle of the tooth in *E. caballus* (Plate LVII. fig. 1, *m* 1, *m* 2); the lobule *m* is more deeply impressed on the inner side. But the chief distinction is in the minor proportions and more simple structure of the hinder half of *m* 3.

Compared with the Ass (Plate LVIII. fig. 1) the molar series of *Equus spelæus* (Plate LX. fig. 3) shows the larger size of the latter animal, and also the greater antero-posterior extent of the lobule *m*. The non-extension outward of the postexternal angles

of *m* 1 and *m* 2, and the form and proportions of *m* 3, are the points of agreement of the Ass with the spelæan Equine.

The molar series of *Equus spelæus* (Plate LX. fig. 3) bespeaks a larger animal than the Kiang (*E. hemionus*, Plate LVIII. fig. 3). The series is more curved in this Cave-horse. The anterior grinder (*p* 2) is more produced and ends (or begins) more acutely (at *a'*); it is more like that of *Equus caballus* both in dimensions and in pattern. In the shape and relatively larger size of the lobule *m* of *p* 2, the spelæan Equine also resembles the Horse more than the Kiang. The last grinder, *m* 3, has the same relative smallness as in the Kiang, but terminates more acutely, the dentinal lobe, *d*, not being extended backward so as to give the bilobed termination shown in the Kiang and the smaller variety of Cave-Equines. The narrower posterior surface of *m* 1 and *m* 2, due to the non-production outward of the postexternal angle, is a character common to the *Equus spelæus* and *E. hemionus*.

In the Quagga (Plate LIX. fig. 1) the difference in transverse extent of the fore and hind surfaces of *m* 1 and *m* 2 is rather less than in *Equus spelæus* (Plate LX. fig. 3). In this respect, as in the bilobed termination of *m* 3, the molar series of the *Equus spelæus*, var. A (fig. 2, Plate LX.), more resembles that of the Quagga. *E. spelæus*, var. B (Plate LX. fig. 3), shows the same superiority of size to the Quagga as to the Kiang and Zebra, and the same closer resemblance to the Horse in the proportions and pattern of the premolar teeth, and of the lobule *m* of all the grinders. The same observations apply to the comparison of Plate LX. fig. 3 with Plate LIX. fig. 3, *Equus Burchelli*. In the comparison of the upper molar series of the variety B of *Equus spelæus* (Plate LX. fig. 3) with that of *Equus Burchelli* (Plate LIX. fig. 3), besides the greater size of the teeth, there is a difference in the minor extension of the anterior lobule of *p* 2 of the Cave-Equine—the inner enamel-wall of which is continuous to the apex of the lobule, without the indent which marks off the base of that lobule in *Equus Burchelli*; this enamel-wall meets that extended from the outer and anterior ridge, *r*, at almost a right angle in *Eq. spelæus*, var. B, yet forming a less-obtuse point than in var. A, or in *Equus Burchelli*.

The enamel-wall of the valley *e*, *p* 2, makes a retroflex bend at its closed end in *Equus spelæus*, var. B, not present in the Dauw, the Zebra, or the Quagga, nor in *Equus spelæus*, var. A. It is usually present in the Horse.

The inner lobule, *m*, of *p* 3 to *m* 2, in *Equus spelæus*, var. B, has a grinding-surface in which the fore-and-aft extent is greater relatively to the transverse one than in *Equus Burchelli* and *E. Zebra*. In this character both varieties of the spelæan Equine resemble more the Horse than the striped species or the Asses.

The portion of mandible or lower jaw affording the view of the entire series of grinders of the *Equus spelæus*, the subject of fig. 5, Plate LVII., could not be referred (from original juxtaposition in the Cave) to either of the series of the upper grinders from the Bruniquel deposits. But, as the series bears the same proportion in length to the upper molar series of *Equus spelæus*, var. B (Plate LX. fig. 3), which the upper and lower series of grinders show in *Equus caballus*, *E. hemionus*, *E. asinus*, &c., it may be

concluded that the subject of fig. 5, Plate LVII. belonged to the same variety, or came from an individual of the same size, as the subject of Plate LX. fig. 3.

Consequently this series of lower grinders of *E. spelæus* shows the same degree of inferiority of size to that of the large Horse figured in Plate LVII. fig. 2, as is exemplified by the upper molar series; but the resemblance in the essential characters of the grinding pattern, and in the proportions of the individual teeth, is very close. The expansion of the postinternal enamel-fold, *g*, of *p* 2 and *p* 3, is more wavy in *E. spelæus*; but this character is not repeated in the succeeding grinders. The antero-posterior extent of the premolars and of the molars is equal, as it is in *E. caballus*; in the other existing Equines the premolars occupy a greater longitudinal extent than do the molars. The last molar, *m* 3, is narrower transversely, and terminates more acutely than in *E. caballus*. In comparison with the Kiang (Plate LVIII. fig. 4) the lobe *d* of *p* 4–*m* 2 is more compressed and produced, the expansion of the fold *g* is wider in all the grinders, and the terminal lobe, *l*, of *m* 3 is larger in *E. spelæus*. The same remarks apply in the comparison with *E. asinus* (Plate LVIII. fig. 2). In *E. quagga* (Plate LIX. fig. 2) the terminal expansion of *g* resembles in width that in *E. spelæus*, and the lobe *l* of *m* 3, comes nearer in its proportions to that in *E. spelæus*. In the Dauw (Plate LIX. fig. 4) the transverse dimensions of the lower grinders are more equal, do not decrease so regularly or uniformly from *p* 3 backward as in *E. spelæus*.

Upon the whole, from the characters of the lower grinders, I incline to regard the Cave-Equine as belonging rather to the section of true horses than to that of the striped or asinine species.

In the Ass and Kiang the lower canine, in the male, is relatively closer to the incisors than in the Horse (comp. Plate LVIII. figs. 2 & 4 *c* with Plate LVII. fig. 2 *c*); in the Quagga (Plate LIX. fig. 2) the interval between *c* and *i* 3 is about the same as in the Horse.

An entire lower jaw of a fossil Equine from Newer Pliocene deposits at the "Tour de Juvillac" of the river Allier, Puy-de-Dôme (Plate LVII. fig. 6), shows the same relative position of the canine as in *E. caballus*. But this fossil accords so closely in dimensions and in the pattern of the grinding-surface of the teeth with the *E. spelæus*, that I believe it to be of the same race of horses.

The slight difference in the minor relative size of *m* 3 (Plate LVII. fig. 6) is due to the state of attrition of the teeth of the specimen figured, which are from an old horse with the mark entirely worn away from the incisors *i* 1–3. Allowing for the difference of size and age of the individuals supplying the specimens (Plate LVII. figs. 2 & 6), the length of the diastema between *p* 2 and *c* is the same, as is that between *p* 2 and the socket of *i* 3; there is a like correspondence in the length of the symphysis mandibulæ.

The age of the animal whose remains have been obtained from sedimentary freshwater deposits, and the age of the animal from the Cavern, indicate the different circumstances under which they have respectively died—the one probably from old age, the other by the hand of man.

Neither the text (pp. 155, 156) nor the figures (plate iii. Pachydermes) relative to the remains of Equines, in the 'Recherches sur les Ossemens Fossiles du Puy-de-Dôme,' by CROIZET and JOBERT, 4to, 1828, allow of further deductions beyond the fact that they relate to a species of the size of *Equus spelæus*, and, like it, more resembling the Horse than the Ass*.

In the collection of Equine fossils from freshwater beds at the "Tour de Juvillac" (alluvion supérieur of BRAVARD'S MS. Catal.) are two series of grinders, each from the left side of the upper jaw, one agreeing in size with those of var. A of *Equus spelæus*, the other with those of var. B. But the smaller series has the last molar, *m* 3, less bilobed behind than in var. A (Plate LX. fig. 2, *m* 3); it more resembles that in var. B (fig. 3, *m* 3). The series of the smaller grinders of the Puy-de-Dôme Equine are in a less straight line than in Plate LX. fig. 2, their curve agreeing with that of var. B, Plate LX. fig. 3. For the rest, the correspondence of the series of molars from the Auvergne beds (No. 34657 of Register, Brit. Mus.) with that of the Cave-Equine (Plate LX. fig. 2) is so close as to leave no doubt as to their specific and racial identity. The same conclusion is enforced by a comparison of the series of molars of larger size from the Auvergne beds (No. 34658 of Register) with the series of var. B from the Bruniquel Cavern (Plate LX. fig. 3). In both instances the evidence of similarity, under the slight difference of size, is such as to impress one with a conviction that such difference relates to variety of size or difference of sex, rather than to race or species.

Comparison of the teeth of Equus spelæus *with those of other fossil Equines.*

The upper molars of *Equus spelæus* differ from those of *Equus fossilis*, Ow.†, from the Oreston limestone fissures, in the greater transverse breadth of the crown as compared with the fore-and-aft diameter (comp. *p* 4, fig. 3, Plate LX. with fig. 143, *op. cit.*). Like the molars of the recent *E. caballus*, those of *E. spelæus* are more quadrate in transverse section, less narrow transversely. The lobule *m* is broader transversely, and the ridge, *n*, is thicker.

The lower molars of *E. spelæus* (Plate LVII. fig. 5, *p* 4) show the same difference from the fossil ones from the Oreston Cave-fissures (fig. 145, *op. cit.*), viz. in the greater relative transverse breadth, agreeing in this respect with the lower molars of the existing horse.

Not any of the fossil Equine teeth from Bruniquel show the degree of plication and

* All the Equine fossils from upper pliocene beds at Malbattu, Puy-de-Dôme, are referred "à une seule espèce dont la taille approche de celle des zèbres et des grands ânes" (CROIZET and JOBERT, *op. cit.* p. 155).

† Brit. Foss. Mam. p. 383, fig. 143. The last milk-molar, *d* 4, of this extinct species figured by RÜTIMEYER (*op. cit.* tab. i. fig. 12, D 1) is 32 millimetres in fore-and-aft diameter, 20 millimetres from the outer middle ridge to the inner part of the lobule *m*. Its successor, the last premolar, *p* 4, figured in 'Brit. Foss. Mammals,' fig. 143, has the same fore-and-aft diameter, with an increase of breadth of 5 millimetres, across the same part of the grinding-surface; RÜTIMEYER'S figures, *op. cit.* tab. i. 7, 8, 10, are true molars of *E. fossilis*, Ow.; fig. 6 is a permanent molar of another species more nearly allied (if not belonging) to *Equus caballus*.

the thinness of the enamel-folds which characterize the *Equus plicidens* from Oreston* and from Newborne, North Carolina†.

The inner enamel-folds of the upper grinders of var. B of *Equus spelæus* are more wavy than those in var. A; but if the first upper grinder, *p* 2, of *Equus spelæus*, var. B (Plate LX. fig. 3), be compared with that tooth of *Equus plicidens* ('British Fossil Mammals,' p. 392, fig. 152), it will be seen that, besides the thicker and less plicate enamel of *E. spelæus*, the crown is longer, and more acute anteriorly, in the Bruniquel Equine. The differences presented by the fossil Equines of America will be noticed in a subsequent paper; those which are seen in the Asiatic and European Miocene Horses (*Hipparion*, Cut, fig. 3) are still more decisive.

Amongst the less complete specimens of Equine jaws and teeth from the Cave of Bruniquel a few were found which illustrated phases of dentition, and lend further help in tracing out the affinities of the species. The subject of Plate LX. fig. 4 is the grinding surface of the last four molars, left side, upper jaw, of a young animal, with the first and second true molars, *m* 1, *m* 2, abraded by mastication, and with the last premolar, *p* 4, and last molar, *m* 3, not yet in place. This phase of dentition is almost identical with that shown by the Zebra (Plate LX. fig. 1). But there the summits of the inner lobes of *p* 4 have began to show attrition; whilst in the Cave-Equine the antero-internal lobe of *m* 3 has just been touched, and no part of *p* 4 shows any action of the opposing tooth. Occasionally, in *Equus caballus*, the last molar a little precedes the last premolar in coming into action. At the phase of development shown in Plate LX. figs. 1 & 4, the analogy of the immature grinder, *p* 4, to the fully developed one in the palæontologically earlier Equine (*Hipparion*) is interestingly exemplified. The inner lobule, *m*, is a column detached at the summit, which when abraded, as in Plate LX. fig. 1, *p* 4, shows an island of dentine girt by enamel, as in the corresponding, but older and more worn, tooth of *Hipparion*. The earlier confluence of the column with the body of the tooth in *Equus*, occasions the earlier conversion in the course of attrition of the island into a peninsula, as in *m* 1 & *m* 2 of figs. 1 & 4. The later confluence of the column, or the maintenance of its distinctness nearer to the base, occasions the longer retention of the insular figure of *m* in the upper molars of *Hipparion*; but in old or much-worn grinders of this genus it also shows continuity of dentine with the lobe *c*.

The young *Equus spelæus* differs from the young Zebra in the greater relative size of the column *m*, leading to the corresponding greater antero-posterior and transverse diameters of the lobe *m* when worn into union with the rest of the tooth, as in Plate LX. fig. 3, *p* 4.

The nearer affinity to *Equus caballus* is likewise shown by the larger size of the first and second molars (*m* 1, *m* 2, fig. 4). But the last molar retains, in the present young

* Brit. Foss. Mam. p. 392, figs. 152, 153.

† Leidy, Proc. Amer. Acad. of Sci. Philadelphia, September, 1847, p. 262.

spelæan Equine, the small relative size distinguishing all its kind from the larger variety, at least, of the modern *Equus caballus*. The size of *m* 1 and *m* 2 in Plate LX. fig. 4 accords with that of *m* 1 and *m* 2 in fig. 3, as does also the plication of the inner enamel, and the form of *m* 3, as indicated by the germ in fig. 4, *m* 3. But at the stage of attrition of *m* 1 and *m* 2 in the young animal the proportion of length to breadth of the grinding-surface is nearer that in those teeth of fig. 2, Plate LX.

Most of the Equine fossils from the Cave of Bruniquel are from young individuals. In Plate LX. fig. 5, is figured a fragment of the left upper jaw, with the first permanent grinder, *p* 2, about to cut the gum; the less-advanced second, *p* 3, and third, *p* 4, premolars had not displaced the corresponding deciduous teeth, *d* 3, *d* 4, which had been worn nearly to the much absorbed stumps. This phase of dentition corresponds with that of a colt of *Equus caballus* between two years and two years and a half old. The upper deciduous molars, *d* 3, *d* 4, of *Eq. spelæus* (fig. 6, Plate LX.) differ from those of the Zebra and Ass, not only in their larger size, but in their greater breadth transversely, relatively to their length of grinding-surface, albeit they show the degree of narrowness which characterizes the milk-molars in *Equus caballus* (Plate LVII. fig. 3). The lobule *m* is relatively larger and broader from without inward.

In the subject of Plate LVII. fig. 7, the first lower permanent grinder, *p* 2, has come into place and has been worn sufficiently to expose the characteristic markings of its grinding-surface. The correspondence of the pattern to that in the more worn homologue of the mature Cave-Equine (Plate LVII. fig. 5, *p* 2) is instructively close. The anterior division of the terminal expansion of the fold *g* shows the same crenation of the outer enamel-wall; the fold *k* has the same simple bifurcation. The correspondence is instructively close, also, with *p* 2 in Plate LVII. fig. 6. The permanent mid incisors, *i* 1, fig. 7, have displaced their deciduous predecessors, and have been worn down to the 'mark.' The contiguous permanent incisors, *i* 2, are just appearing above the alveoli, and the summits of the permanent canines, *c*, are visible. This state of dentition indicates a young stallion, or colt, of about three years. The correspondence with the Equines from the French quaternary or pleistocene sedimentary bed (Plate LVII. fig. 6), in the length of the diastema and the position of the canines, is instructively close; the larger size of the wedge-shaped mid incisors, *i* 1 in fig. 7, is due to the limitation of attrition; in the older individual these teeth are worn nearly to their inserted fang (fig. 6, *i* 1).

In the subject of Plate LVII. fig. 8, the permanent canine, *c*, has pushed through the socket; its unworn summit shows the folding back of the margins of the enamel, causing the bicanaliculate inner or hinder surface characteristic of that tooth in Equines. In the lower molar series of the Equine from the freshwater beds of the Puy-de-Dôme, the fold *f* so nearly touches the same part of the fold *g* as to suggest that they may have been continuous at the earlier stage of attrition shown in the young colt from Bruniquel.

I would have given the dentition, and the results of comparison of my fossils therewith, of the Ghor-khur (*Equus onager*, Pallas*), of the *Equus tæniopus*, Heuglin, and of the Koulan (*Equus hemippus*, Isid. Geof. St.-Hilaire†); but to wait for such opportunities threatened indefinite delay. The observations, moreover, described in the preceding pages, carried on at intervals of leisure, and as opportunities occurred, had brought me to conclusions relative to the Equine fossils of the Cavern of Bruniquel which seemed worthy of being communicated to the Royal Society. I nevertheless can only regard them as a commencement of that which the subject of Equine fossils in general requires. There remains to be worked out, and no doubt ultimately will be worked out, the range of variety to which the dental characters of the several existing species of Equines may be subject.

Specimens, however, of Dshiggettais, Kiangs, and other wild Asses or unstriped Equines, are rare in Menageries and Museums, as are also those of Zebras, Quaggas, Dauws, and others of the striped species.

But a beginning must be made; and if I may judge from my own wants and wishes, the figures illustrative of the present Memoir will prove acceptable to those who may be better qualified to carry on this line of palæontological research.

I subjoin a note of the range of size, expressed in French millimetres, which I have observed in certain molars of existing Equines, as to antero-posterior extent or length of grinding-surface, upper jaw:—

In *Equus caballus*, *p* 2, from millims. 36 to 40; *p* 3, from millims. 28 to 32; *p* 4, from millims. 26 to 30; *m* 1, from millims. 24 to 28; *m* 2, from millims. 25 to 27; *m* 3, from millims. 28 to 37 (*m* 3 in some varieties of Horse does not exceed *p* 3 in length); *d* 2, from millims. 34 to 39; *d* 3, from millims. 27 to 30; *d* 4, from millims. 28 to 29.

In *E. asinus*, *p* 2, from millims. 28 to 35; *m* 3, from millims. 21 to 24.

In *E. zebra*, *p* 2, from millims. 32 to 35; *m* 3, from millims. 23 to 24.

In *E. quagga*, *p* 2, from millims. 37 to 39; *m* 3, from millims. 22 to 29

In *E. hemionus*, *p* 2, from millims. 33 to 36; *m* 3, from millims. 22 to 25.

In *E. Burchelli*, *p* 2, millims. 38; *m* 3, millims. 25.

In *E. spelæus*, *p* 2, from millims. 37 to 39; *m* 3, from millims. 25 to 27.

For further aid in comparisons the following dimensions are given in the subjoined Table of Admeasurements.

* A mare, from Kutch, was received at the Zoological Gardens in May 1849.

† A mare, from Syria, was presented to the Zoological Society in October 1854.

TABLE OF ADMEASUREMENTS.

	Length of series of grinders.				Length of series of premolars, *p* 2, 3, 4.		Length of series of molars, *m* 1, 2, 3.		Length of series of premolars, *p* 2, 3, 4.		Length of series of molars, *m* 1, 2, 3.		From *p* 2 to *i* 3.		From *p* 2 to *i* 3.	
	Upper.		Lower.		Upper.		Upper.		Lower.		Lower.		Upper.		Lower.	
	in.	lines.	in.	lines.	in.	lines.	in.	lines.	in.	lines.	in.	lines.	in.	lines.	in.	lines.
Equus caballus, large var.	7	7	7	8	3	11	3	8	3	9	3	11	5	7	5	0
—— ——, small var. ...	6	8	6	7	3	9	3	1	3	4	3	3				
—— asinus	5	9	6	0	3	2	2	7	3	1½	2	9	3	0	2	8
—— hemionus	6	0	6	1	3	4	2	8	3	2	2	10	4	0	3	4½
—— quagga	6	4	6	5	3	4	3	0	3	5	3	0	3	0	2	9
—— Burchelli	6	6	6	7	3	6	3	0	3	6	3	1	3	5	3	4
—— zebra	6	6	.....		3	6	3	0	.....		.....		.....		.....	
—— spelæus, No 1*.....	6	6	.....		3	6	3	0	.....		.....		.....		.....	
—— ——, No. 2†	7	2	.....		4	0	3	2	.....		.....		.....		3	6
—— ——, No. 3‡	6	7½	.....		3	7½	3	0½	.....		.....		.....		.....	
—— ——, No. 4§	7	0	7	3	4	7½	3	0	3	9	3	6	.....		3	6

From other parts of the enduring framework of the Horse-tribe, more or less petrified in the brecciated deposits of Bruniquel, but little aid can be had in the determination of the question of their affinities in that natural and slightly differentiated group. Every bone containing a marrow-cavity has been split or fractured to get access to that savoury and nutritious substance. The dental canal and roots of the teeth have been exposed in every specimen of upper and lower jaws for the same purpose. Some carpal and tarsal bones are entire: amongst the latter is the characteristic astragalus of an *Equus*, showing its deep and oblique pulley. It differs from that of our present average-sized horses only in the same degree of size as do the teeth and jaws previously described, and it doubtless belongs to the same race.

A portion of femur shows a longitudinal extent from the lower part of the third trochanter to the upper part of the fossa, giving origin to the gastrocnemius externus, which, compared with the circumference of the shaft midway between these parts, indicates a proportion of femur corresponding, in relative length to thickness, more with that of the Horse than with that of the Ass.

Concluding Remarks.—The conclusions to which I have been led by the preceding comparisons are as follows:—First, that the Bruniquel Equine fossils are identical in race with those which have been obtained from certain freshwater postpliocene or quaternary beds in France, as from the locality, for example, traversed by the river Allier, near the Tour de Juvillac, Puy-de-Dôme. They present a closer resemblance, in all the points compared, with those 'fossils of deposit' than with any other known extinct or recent Equine. Secondly, I infer from the sum of the known characters of this rather small and seemingly extinct race of Equines, that they were more nearly allied to the true Horses, forming the limited genus *Equus* of modern Mammalogy, than to the Zebras and

* Var. A, Plate LX. fig. 2. † Var. B, Plate LX. fig. 3.

‡ From freshwater beds, Tour de Juvillac, Puy-de-Dôme, smaller variety.

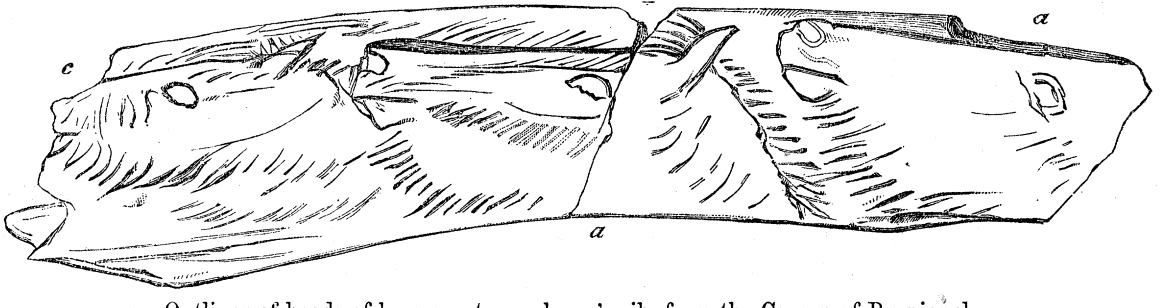
§ From freshwater beds, Tour de Juvillac, Puy-de-Dôme, larger variety.

Asses, included in the genus *Asinus* of Gray. These latter, whether striped or unstriped, want, as is well known, the callosity on the inner side of the leg, called 'châtaigne' by French veterinarians and 'sallander' by English ones, in the hind limbs, and have it only in the fore limbs; while the true Horses have it in both fore and hind limbs. The species of *Asinus* have the long hair of the tail limited to a terminal tuft, the rest being slender and clothed with short close hair like the skin of the body: in the species of *Equus* proper the skin of the tail developes the long hair from its base, giving the graceful flowing form to that appendage in that higher group. Asses and Zebras have a short close 'pelage,' at least in the summer season; and at no part of the year have I ever seen in any of the striped or unstriped *Asini* at our Zoological Gardens such a beard-like development of hair from the skin of the mandible as that which is notable in the wild Horse of the Pampas and in our own unkempt Exmoor or Shetland ponies and cart-horses, but which the neat groom is careful to eradicate in the trim horses used for carriage-draught or for saddle.

The artistic instinct or propensity of the cave-dwellers with flint and bone weapons, of which I communicated examples in my former Paper*, has left interesting and unexpected evidence, helping toward the solution of the main question as to the nature of the wild Equines which they, most probably, hunted, trapped, and killed for food.

On the two sides of a portion of one of the broad and flat ribs of the Horse, the primeval artist has cut the outline of the head of the living animal. Repeating his sketch as often as the scale of his drawing and the size of the smooth bone selected would permit, he has thus been able to put two heads and part of a third on each side of his bone (Cuts, figs. 7 & 8).

Fig. 7.



Outlines of heads of horses cut on a horse's rib, from the Cavern of Bruniquel.

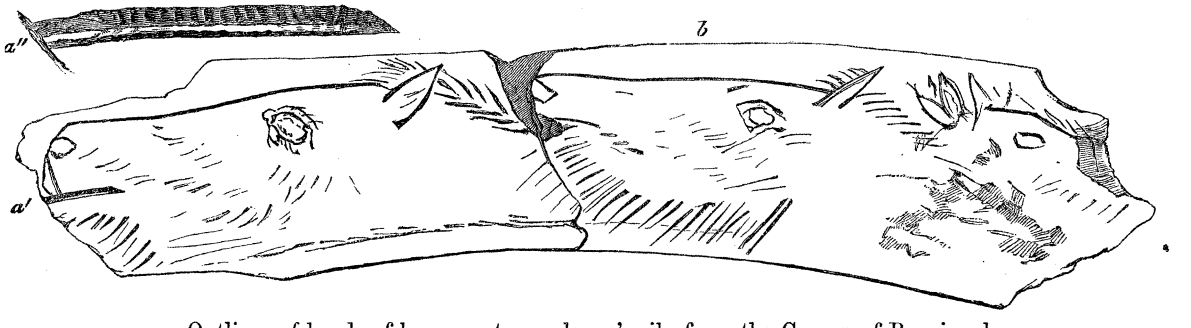
The collocation may show his intention to suggest the herds in which the wild animals congregated, and the single lines or files in which they fled†. The differences of size

* See Philosophical Transactions, 1869, p. 517, Cuts 5 & 6.

† Colonel Hamilton Smith, who was attached to the allied armies in the Campaign of 1813–14, gives, perhaps, the most trustworthy evidence of a race of wild Horses, taken from an intelligent orderly Cossack, who served as a Russian interpreter, and who had passed ten or twelve years in the Mongolian deserts near the frontier of China. He describes the chin and muzzle of such horse as beset with bristles, the tail bushy from the root, but not descending lower than the hocks; when alarmed they fled "in lines or files" with the stallions in advance and also bringing up the rear. (In 'Jardine's Naturalist's Library,' Equidæ, 12mo, 1841, p. 161.)

may also have been meant to indicate the horse (*a*), the mare (*b*), and the foal (*c*). Three of the heads, two on one side and one on the other, are of the largest size, and measure from the setting-on of the ear to the nostril 1 inch 8 lines, or 1 inch 9 lines. A single head on one side (fig. 8, *b*) gives 1 inch 5 lines in the same admeasurement; a single head on the opposite side (fig. 7, *c*) gives but 1 inch; the depth of the head in this indication of a colt or filly is in proportion to the minor length, as compared with the full-sized specimens. But what is most to my present purpose is the evidence of the length of the beard-like hairs in the stallions, and the pointed ears in all. The short pointed ears, associated with the bushy tail, are evidence of the affinity of the animal figured in cuts 7 & 8, to *Equus* proper. The ears alone would not have been of value, since those of the Kiang have the shape and almost the proportion of the horse's ears. In the wild Ass or Onager, the length of the ears and their less acute termination are conspicuous. The ears are large and obtuse in all the Zebrine groups. The profile of the fore part of the head (chaffron or 'chanfrein') of the mature horses is straight, as in the Greek sculptures *. It is a little convex in the outline of what I conclude to be the head of a young animal (fig. 7, *c*), in which, from the jaws not bearing the full dentition, they are shorter, and the eye (orbit) is accordingly more nearly midway between the ear and the angle of the mouth.

Fig. 8.



Outlines of heads of horses cut on a horse's rib, from the Cavern of Bruniquel.

The accuracy with which the characters of *Cervus tarandus* are rendered, in the outline of the head and antlers of which a figure was communicated to the Royal Society in Part I. (June 9th, 1864: Cuts, figs. 5 & 6, p. 517), justifies the inferences deduced from the works of an equally accurate primeval artist, to whom we are now indebted for, perhaps, the most satisfactory evidences of the affinities of the *Equus spelæus*. The mouth (Cut, fig. 8, *a'*) is not indicated by a mere line or simple incision; the outer ridges of the Equine molars must have suggested the character of a multiplicity of teeth. Viewed by the hand magnifier, one sees, in fact, that the prehistoric Troglodyte has expressed his idea of the interlabial structures, conventionally no doubt, by a row of minute notches above and below the line representing the meeting of the molars. An accurate drawing of this appearance, so

* On the Elgin Marbles the domesticated horses are not larger than the wild animals which have left their remains in the Bruniquel cave.

magnified, is given at *a''*, fig. 8. But the help which these draughtsmen of the old cave-dwelling people have undesignedly contributed to the modern man of science does not end here. The difference between the "cauda undique setosa"* and the "cauda extremitate setosa"† is such as could not have escaped the sharp-eyed hunter, nor have failed to be represented in the outlines by the artist of the tribe. Hitherto, so far as I learn, at Bruniquel, only the heads of the contemporary wild horses have been engraved on bone. But in the Cavern of La Madelaine, Dordogne, the antler of a Reindeer (a shed one) was found covered with more coarsely graven outlines of entire Equines (fig. 9),

Fig. 9.

Outline of horse, cut on a Reindeer's antler, from a Cave in the Dordogne.

showing the large or coarse head, characteristic of the wild animal, the short prick-ears, and a tail which unquestionably indicates the wholly clothed character of that part in the true or restricted *Equus* of modern mammalogists. It is repeated in each of seven outlines cut on this antler, is short, or does not extend beyond the hock, and in none is there the slightest indication of a terminal expansion or tuft suspended on a slender stem as in Zebras and Asses.

No satisfactory evidence of an aboriginal feral *Equus caballus* has yet been obtained by the Naturalist. No specimen of such exists in any Museum. The doubts expressed by FORSTER and PALLAS as to the alleged wild horses of the Ukraine, viz. that they might be descendants from strayed domestic horses, have not yet been cleared up. I believe the illustrations contained in the present Paper to be the best, if not sole, evidences of the wild originals of some of our domesticated breeds. Like the alleged wild horses of Prussia, those of Aquitaine, in the time of the flint-armed hunters and cave-dwellers, were doubtless "shy and difficult of capture, but very good venison"‡.

* LINNÆUS, char. of *Equus caballus*, Systema Naturæ, vol. i. p. 100.

† LINNÆUS, char. of *Equus asinus*, Systema Naturæ, vol. i. p. 100.

‡ ERASMUS STELLA, de Origine Borussorum, quoted by Colonel HAMILTON SMITH, *op. cit.* p. 158.

Description of the Plates.

PLATE LVII.

Fig. 1. Working-surface of teeth of upper jaw, *Equus caballus*, ♂.
Fig. 2. Working-surface of teeth of lower jaw, *Equus caballus*, ♂.
Fig. 3. Working-surface of deciduous molars, upper jaw, *Equus caballus*, ♂.
Fig. 4. Working-surface of deciduous molars, lower jaw, *Equus caballus*, ♂.
Fig. 5. Working-surface of lower series of molars, *Equus spelæus* (Bruniquel).
Fig. 6. Working-surface of teeth of lower jaw, *Equus spelæus* (Puy-de-Dôme).
Fig. 7. Fore part of lower part of mandible with first permanent incisors and first right grinder in place, *Equus spelæus* (Bruniquel).
Fig. 8. Portion of left ramus, lower jaw, with first grinder right and point of permanent canine protruding, *Equus spelæus* (Bruniquel).

PLATE LVIII.

Permanent dentition of *Equus asinus* and *Equus hemionus*.

Fig. 1. Working-surface of teeth of upper jaw, *E. asinus*, ♂.
Fig. 2. Working-surface of teeth of lower jaw, *E. asinus*, ♂.
Fig. 3. Working-surface of teeth of upper jaw, *E. hemionus*, ♂.
Fig. 4. Working-surface of teeth of lower jaw, *E. hemionus*, ♂.

PLATE LIX.

Permanent dentition of *Equus quagga* and *Equus Burchelli*.

Fig. 1. Working-surface of teeth of upper jaw, *E. quagga*, ♂.
Fig. 2. Working-surface of teeth of lower jaw, *E. quagga*, ♂.
Fig. 3. Working-surface of teeth of upper jaw, *E. Burchelli*, ♀.
Fig. 4. Working-surface of teeth of lower jaw, *E. Burchelli*, ♀.

PLATE LX.

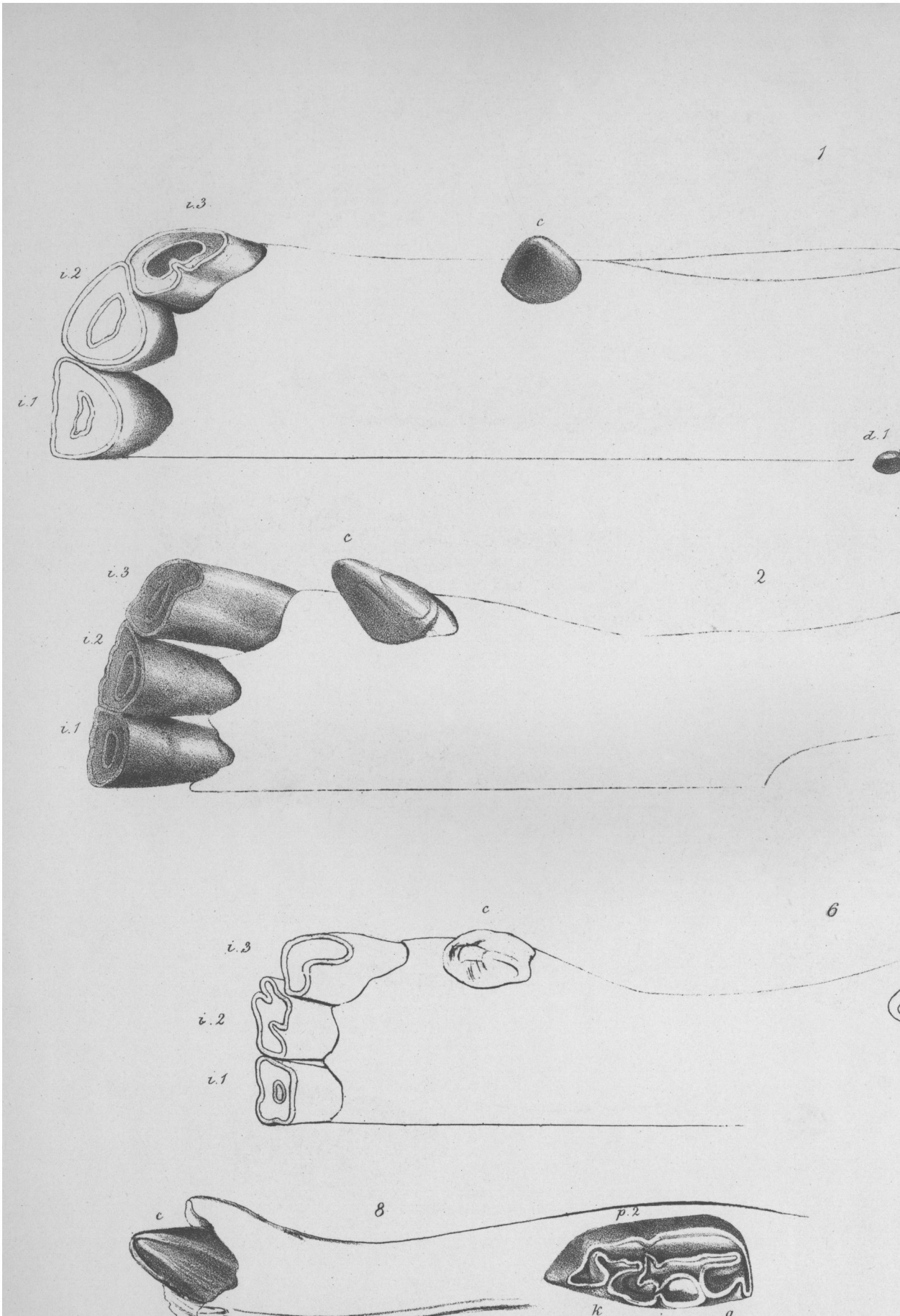
Fig. 1. Working-surface of upper permanent grinders, *Equus zebra*, ♂.
Fig. 2. Working-surface of upper permanent grinders, *Equus spelæus*, var. A.
Fig. 3. Working-surface of upper permanent grinders, *Equus spelæus*, var. B.
Fig. 4. Working-surface of first and second molars, and of the germs of last premolar and last molar of *Equus spelæus*, var. B.
Fig. 5. Outside view of last two deciduous molars and of germs of three functional premolars of *Equus spelæus*, var. B.

Fig. 6. Working-surface of the deciduous molars and germ of premolar, *p* 2, of *Equus spelæus*, var. B.

All the figures are of the natural size; the letters and numerals are explained in the text.

WOODCUTS.

Fig. 1. Details of grinding-surface of upper molar, *Palæotherium*.
Fig. 2. Details of grinding-surface of upper molar, *Paloplotherium*.
Fig. 3. Details of grinding-surface of upper molar, *Hipparion*.
Fig. 4. Details of grinding-surface of upper molar, *Equus caballus*.
Fig. 5. Details of grinding-surface of lower molar, *Rhinoceros*.
Fig. 6. Details of grinding-surface of lower molar, *Equus caballus*.
Fig. 7. Inner surface of a portion of rib, on which have been cut outlines of the head of male, *a*, and young, *c*, of the living *Equus spelæus*.
Fig. 8. Outer surface of the same portion of rib of *Equus spelæus*, on which have been cut outlines of the head of male, *a*, and female, *b*, of that species when alive. (From the Cave of Bruniquel.)
Fig. 9. Portion of antler of Reindeer (*Tarandus*), on which has been cut an outline of the living *Equus spelæus*. (From the Cave of La Madelaine, Dordogne.)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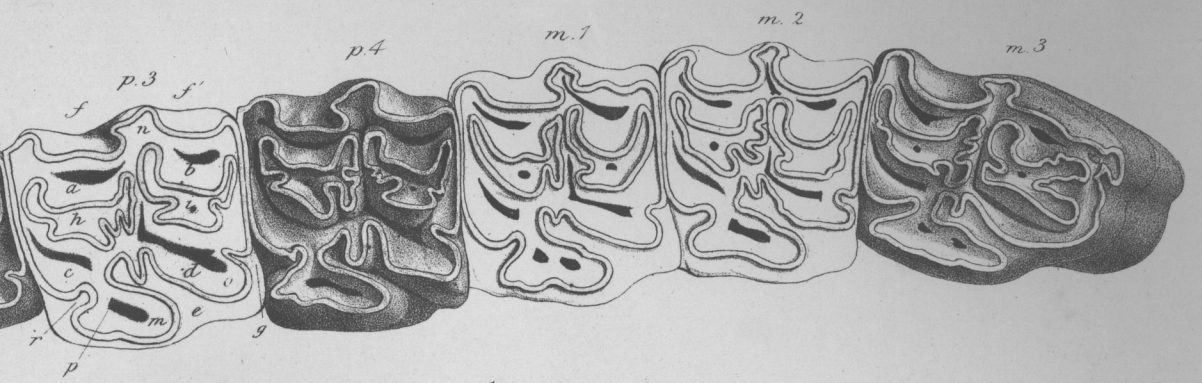
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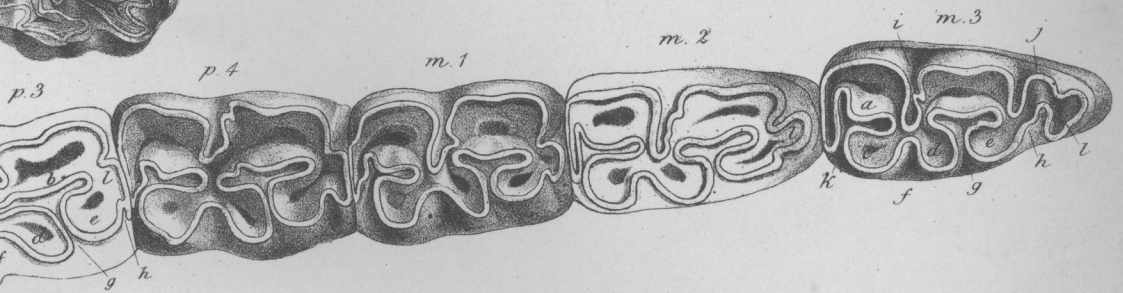
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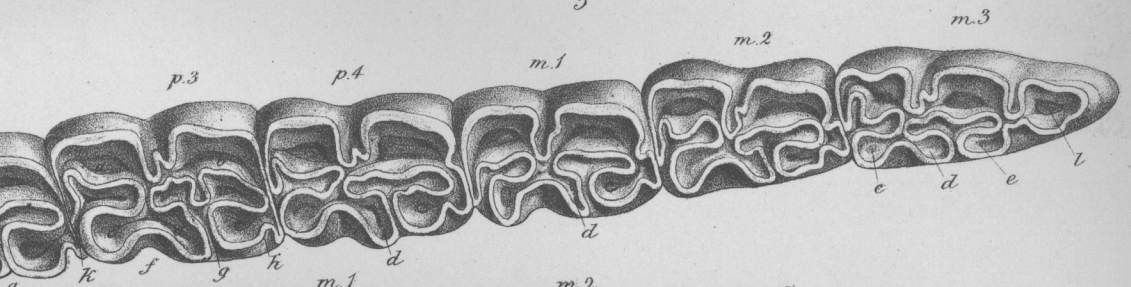
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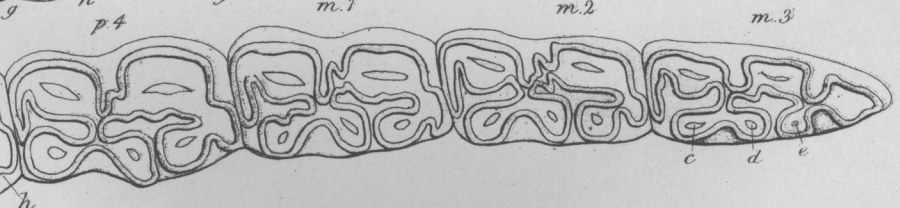
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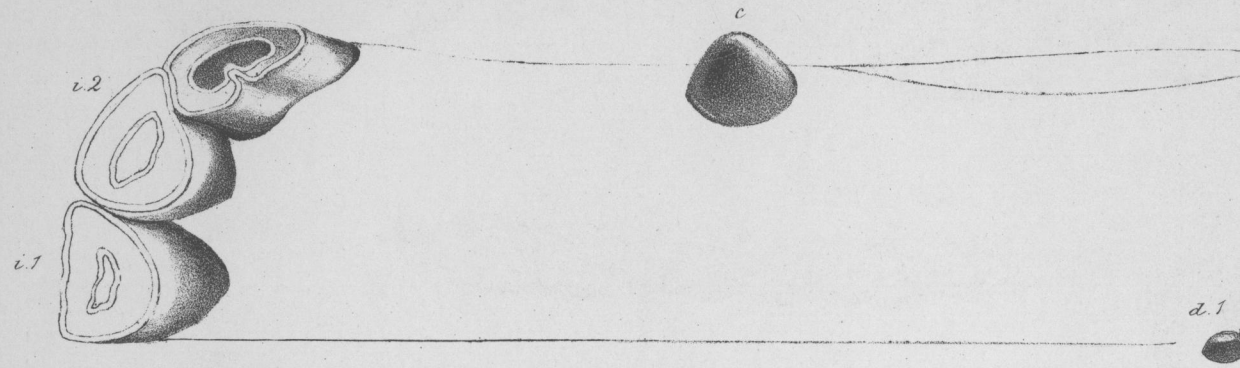
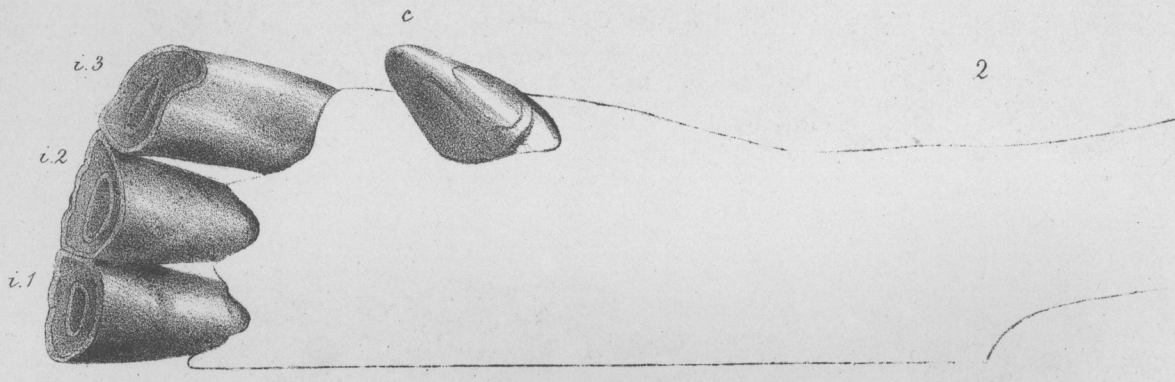
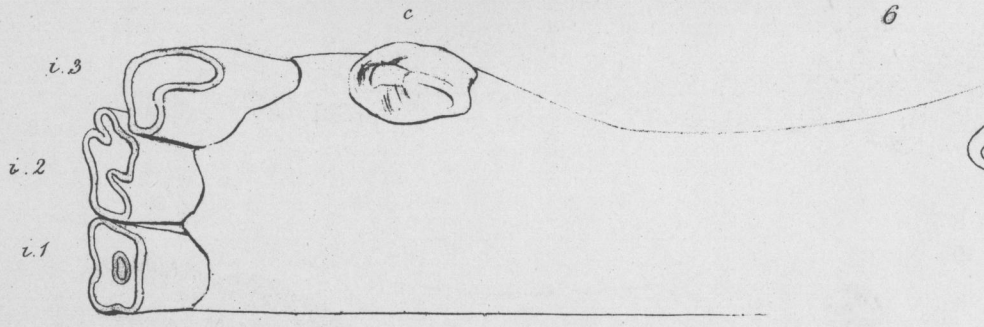
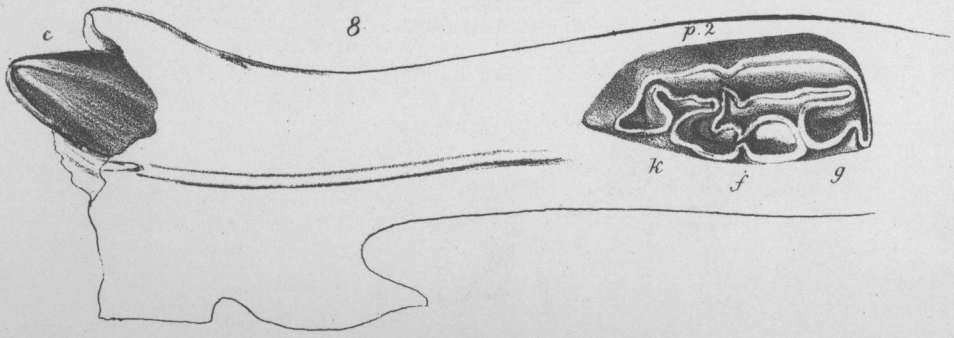




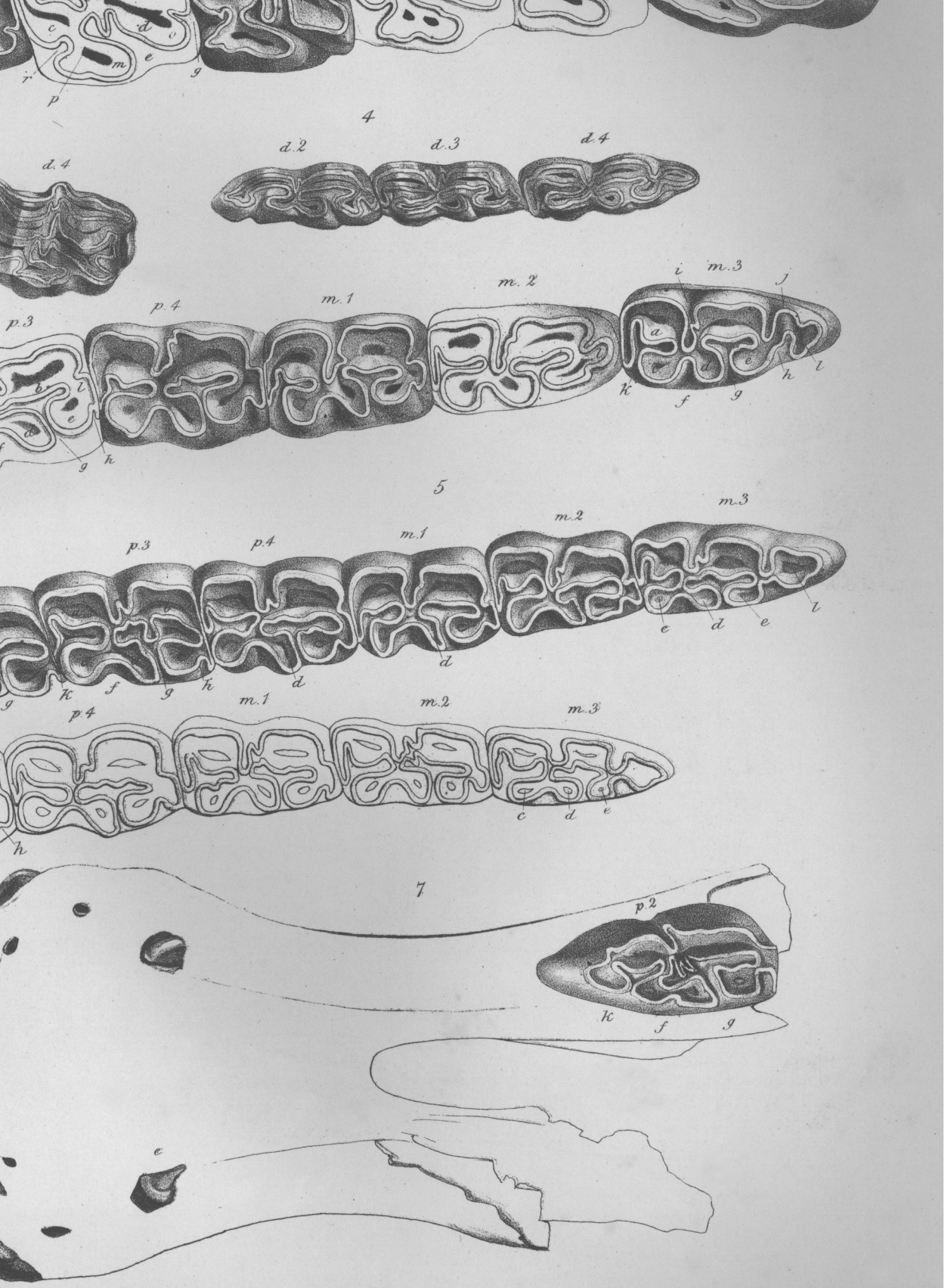




From nat. on stone by J. Erxleben.

1-4. EQUU
6.7. EQUU

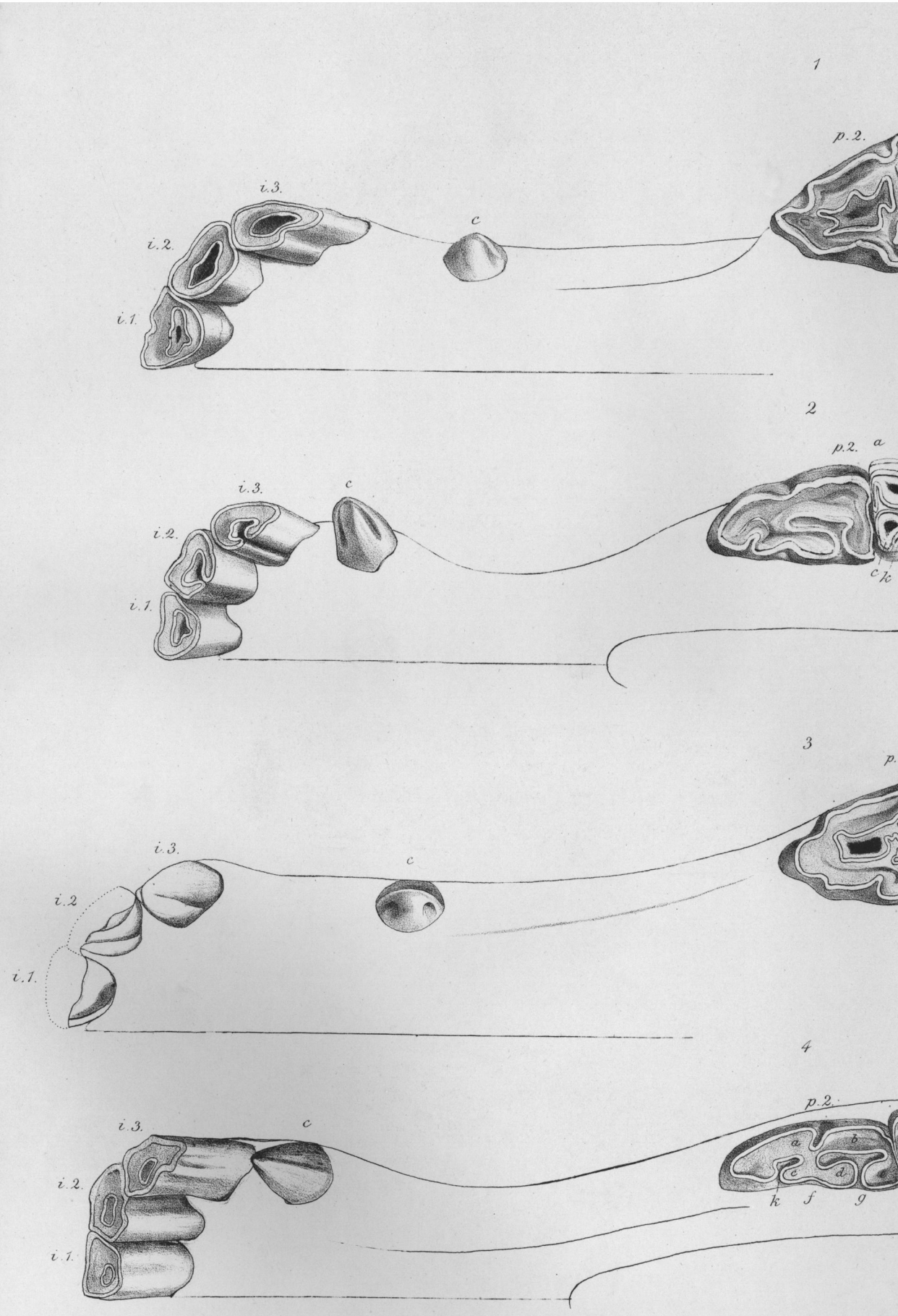
1-4. EQUUS CABALLUS ♂ 5. EQUUS SPELÆUS. *Var. B.*
6.7. EQUUS SPELÆUS 8. EQUUS SPELÆUS. *Ow.* ♂.



ÆUS. *Var. B.*

ÆUS. *Ow. 6.*

W. West. imp.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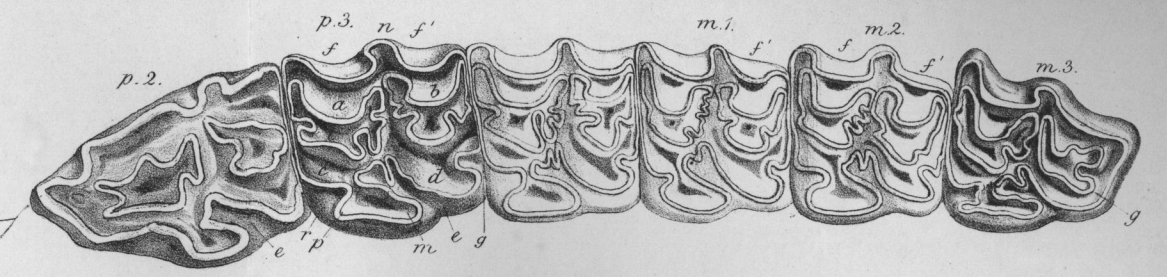
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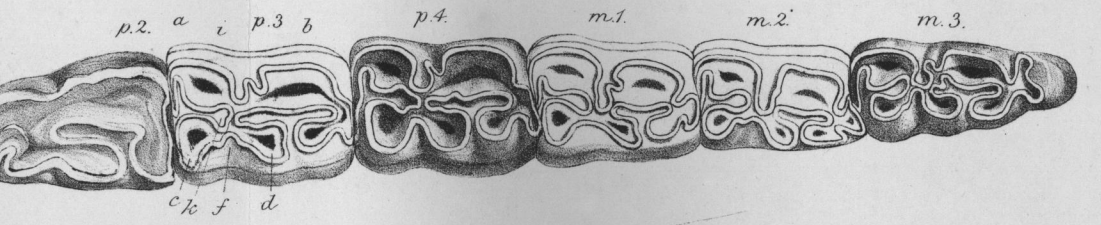
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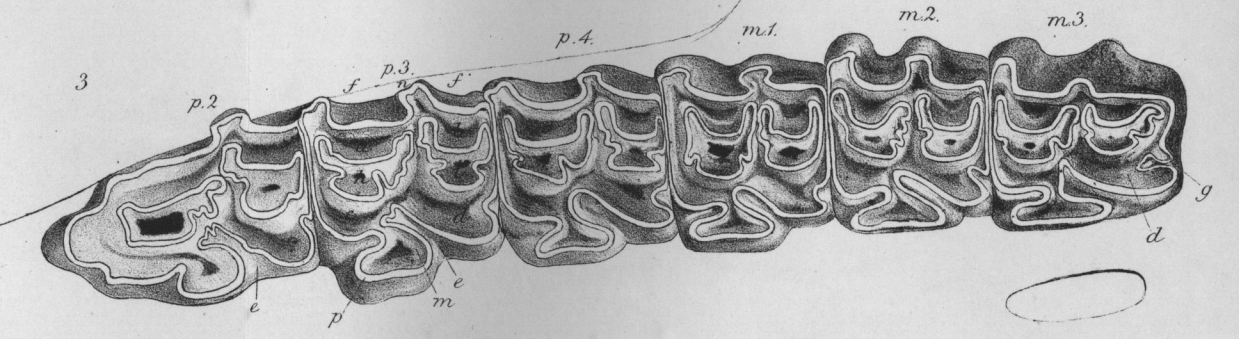
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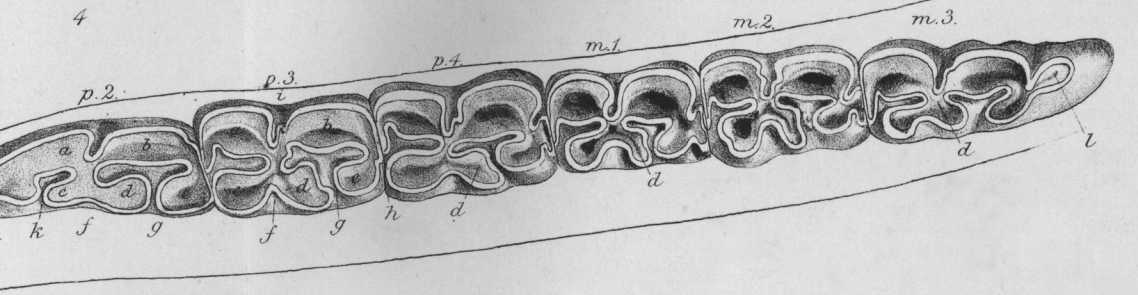
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On stone by J. Erxleben.

1.2. EQUUS ASINUS &.–3.4. EQ

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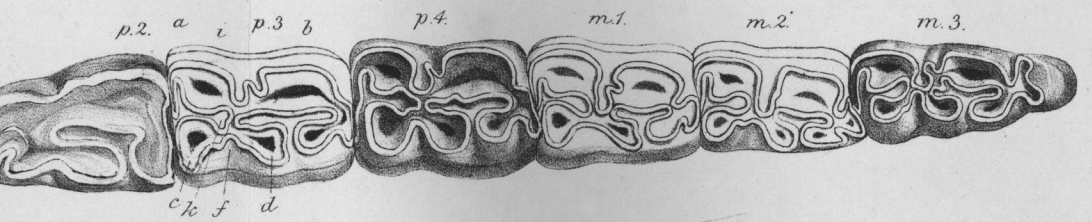
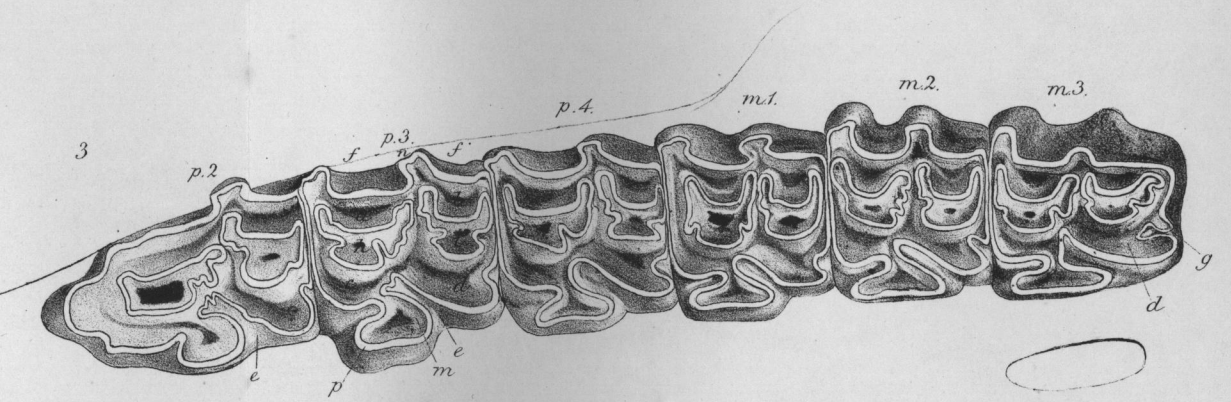
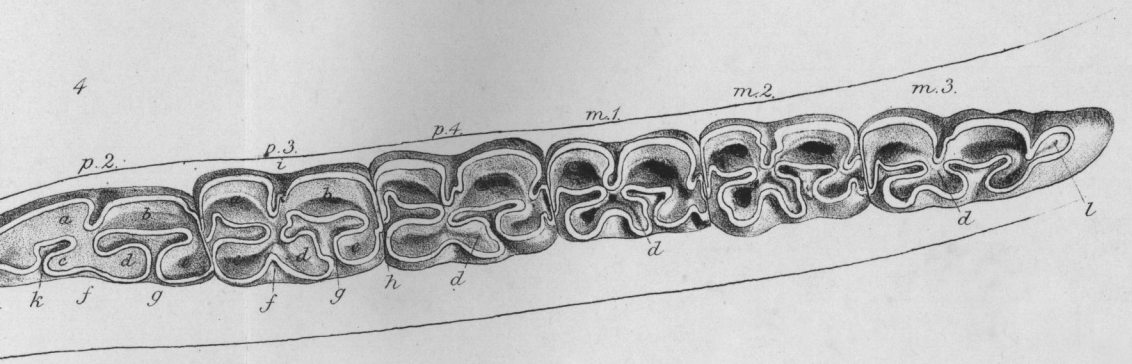
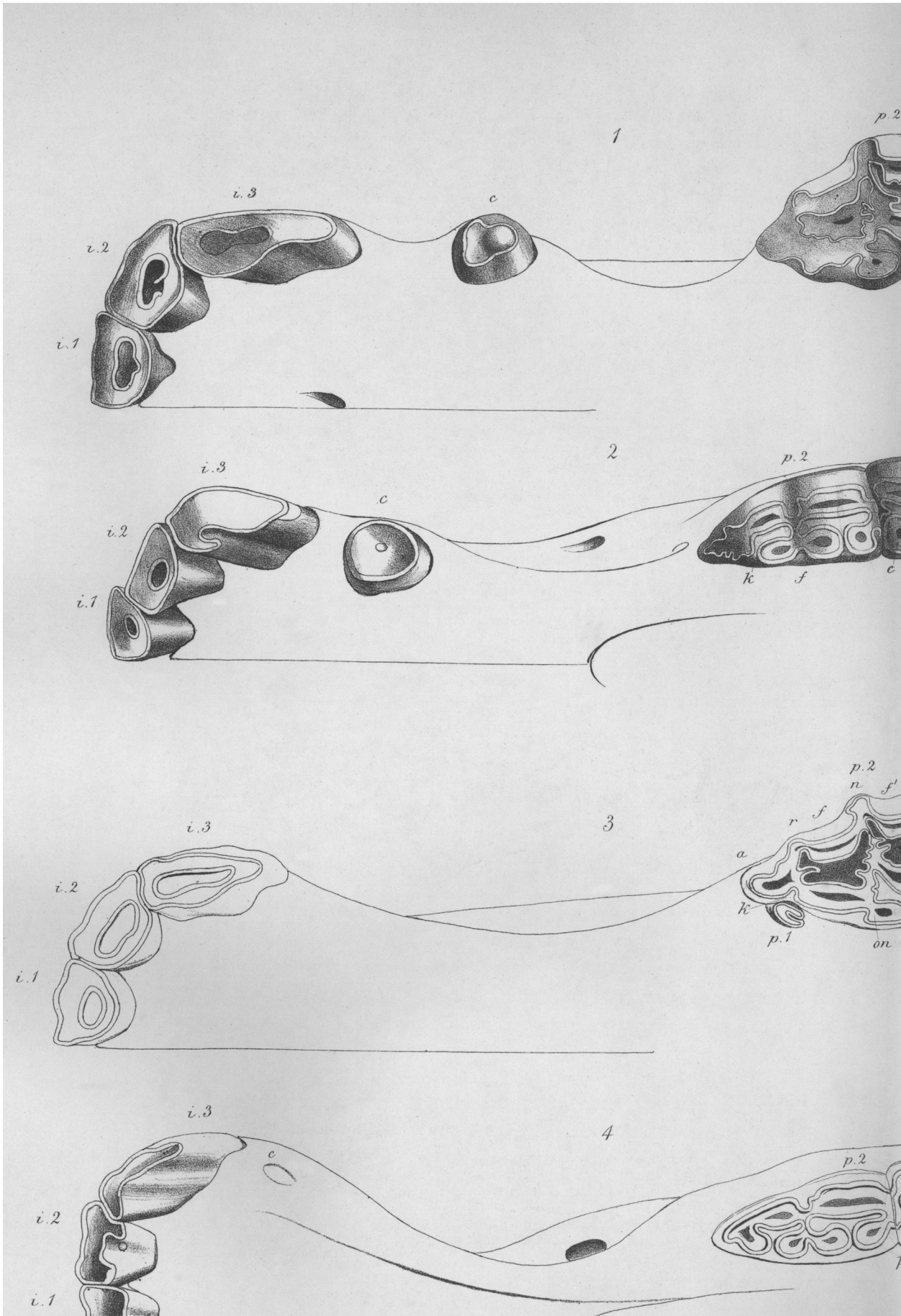






W. West imp.

NUS 3.–3. 4. EQUUS HEMIONUS.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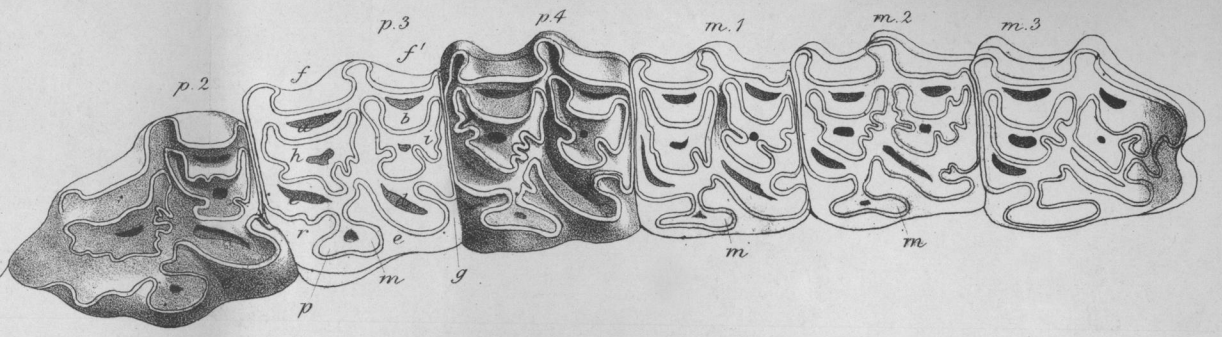
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p.3
f'
f
p.4
m.1
m.2
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b
i
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r
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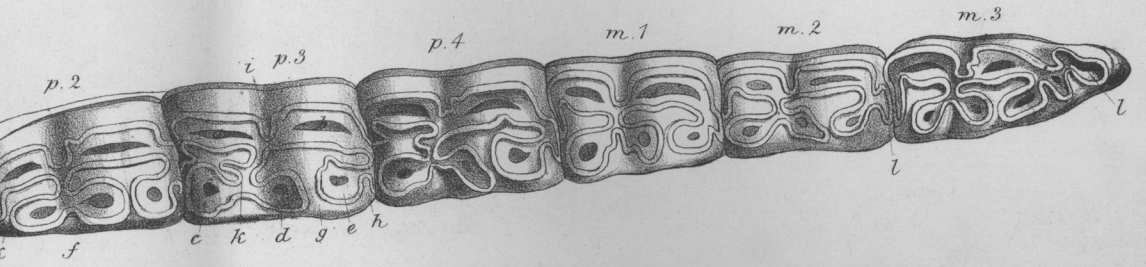
m
m


p.2
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p.3
p.4
m.1
m.2
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l
l
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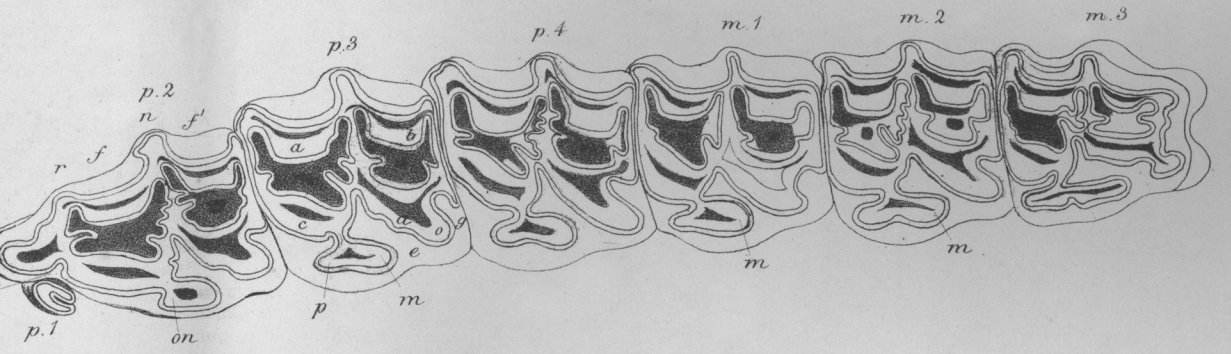
p.3
p.4
m.1
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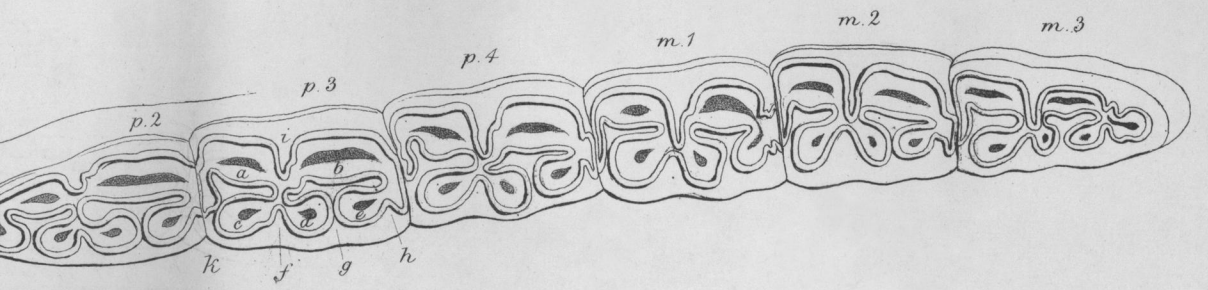
p.1
on


m.2
m.3
p.4
m.1
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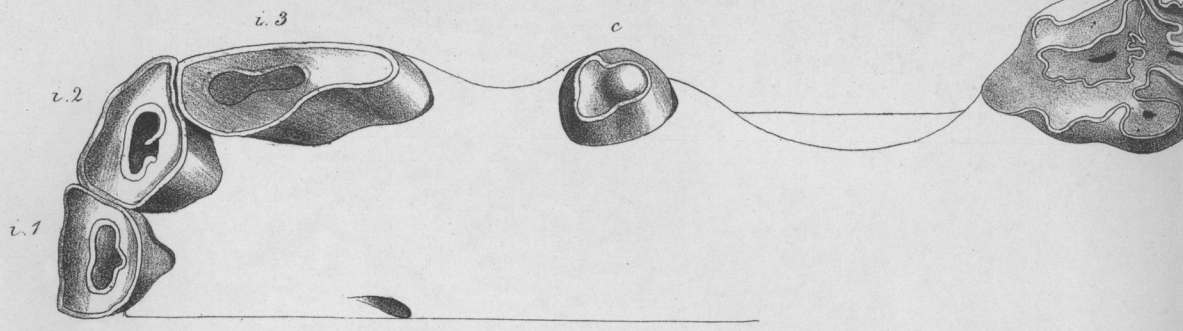
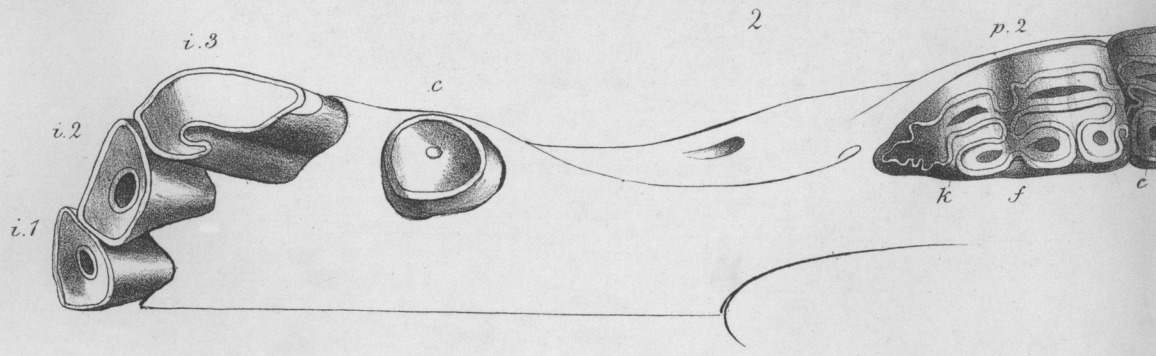
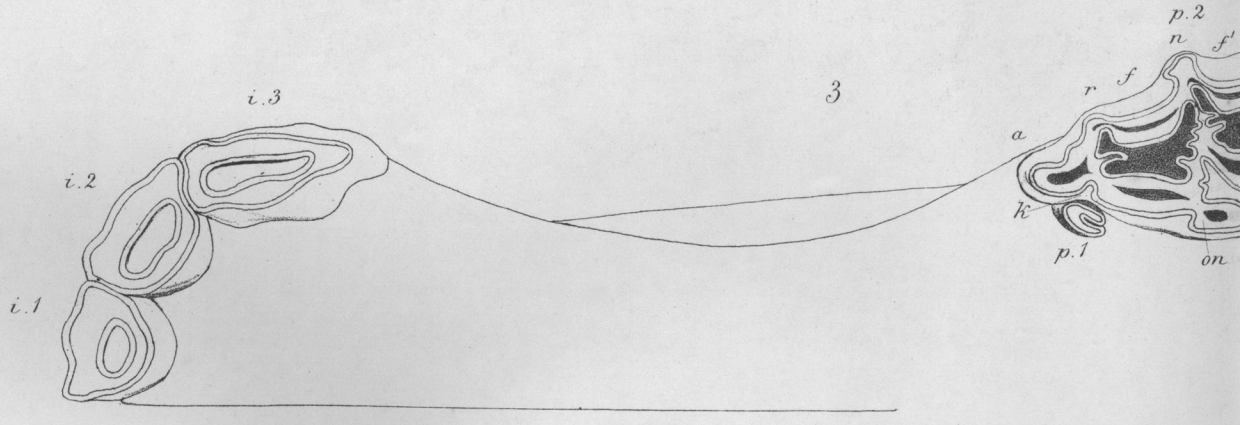
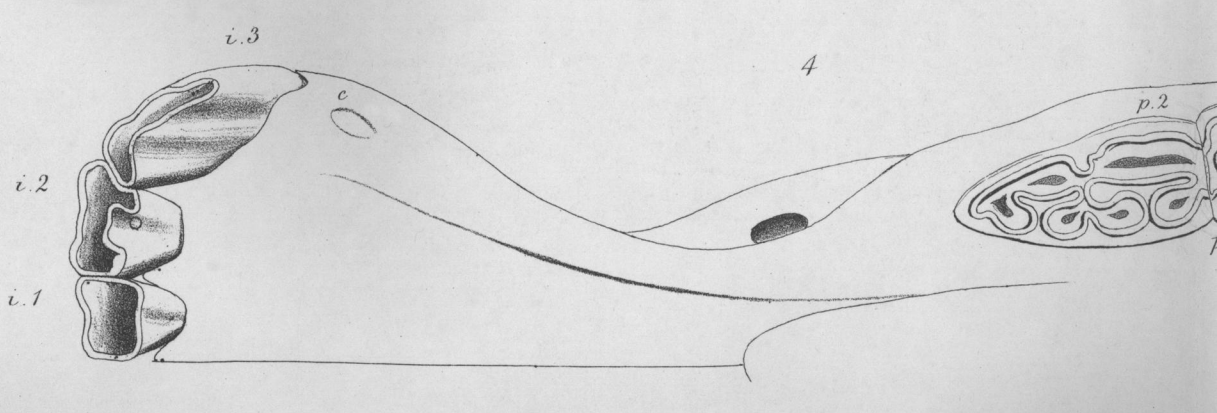
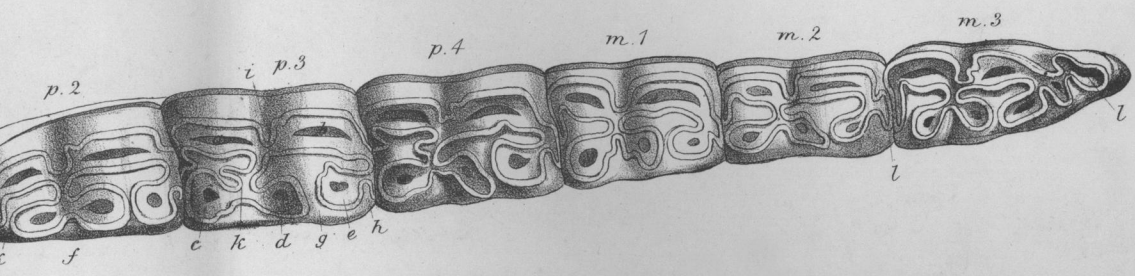


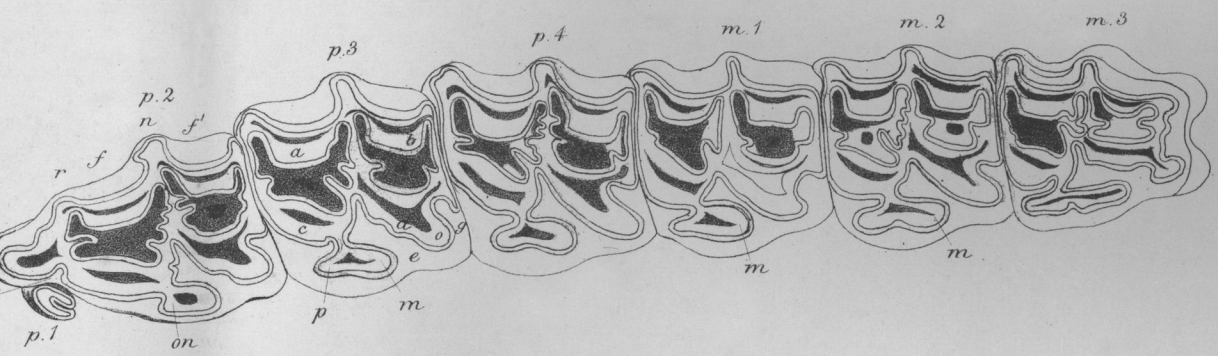


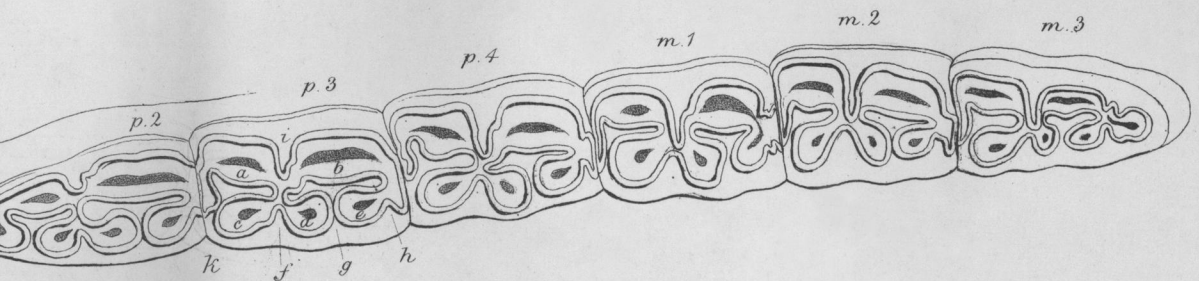




On stone by J. Erxleben.

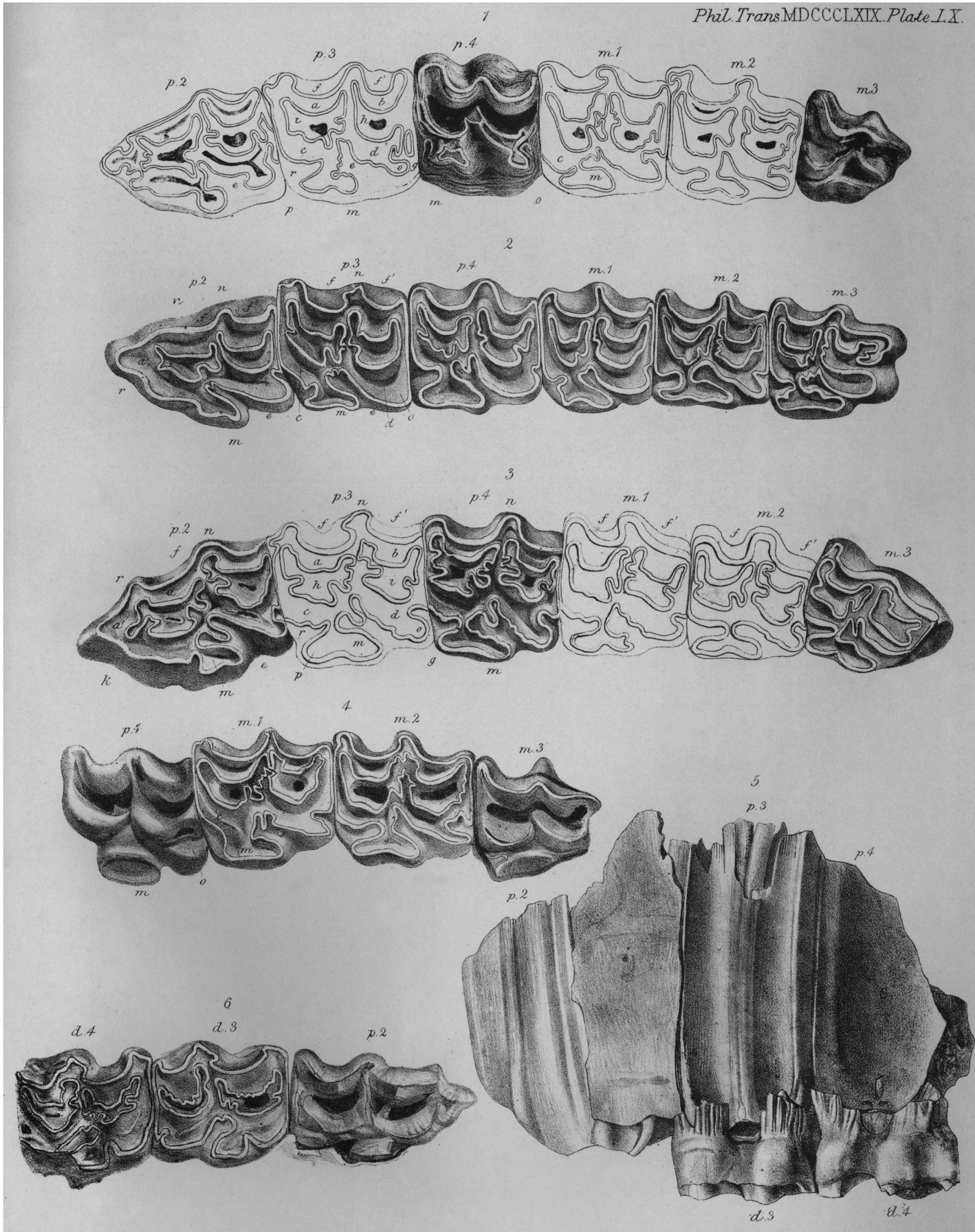






W. West imp.

GA. 6. — 3. 4. EQUUS BURCHELLI. ♀.



On stone by J. Erxleben.

W. West imp.

1 EQUUS ZEBRA.-2 EQUUS SPELÆUS *Var. A*-3 EQUUS SPELÆUS *Var. B*.
4 EQUUS SPELÆUS-5 6 EQUUS SPELÆUS *Ow.*